

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

FXL2T245

General Description

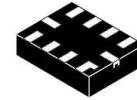
The FXL2T245 is a configurable, dual-voltage-supply translator designed for uni-directional and bi-directional voltage translation between two logic levels. The device allows translation between voltages as high as 3.6 V to as low as 1.1 V. The A port tracks the V_{CCA} level and the B port tracks the 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/\bar{R}) input determines the direction of data flow through the device. The \overline{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/\bar{R} and \overline{OE} are supplied by V_{CCA} .

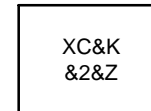
Features

- 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)
 - ◆ 8 kV 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)



UQFN10 (MICROPAK™), 1.6 x 2.1, 0.5P
CASE 523AZ

MARKING DIAGRAM



XC = Specific Device Code
 &K = 2-Digits Lot Run Traceability Code
 &2 = 2-Digit Date Code
 &Z = Assembly Plant Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

FXL2T245

PIN CONFIGURATION

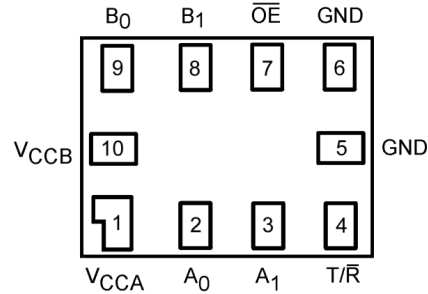


Figure 1. Pin Assignments

PIN DESCRIPTION

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

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 0 V, outputs are in a high-impedance state. The control inputs (T/ \overline{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 T/ \overline{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}.

FXL2T245

ABSOLUTE MAXIMUM RATINGS

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 (T/R, \overline{OE})		−0.5	4.6	
V _O	Output Voltage (Note 3)	Output 3-State		−0.5	4.6	V
		Output Active (An)		−0.5 to V _{CCA}	0.5	
		Output Active (Bn)		−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 VCC 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	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

3. I_O Absolute Maximum Rating must be observed.

RECOMMENDED OPERATING CONDITIONS

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 (T/ \overline{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
ΔV/Δt	Minimum Input Edge Rate	V _{CCA/B} = 1.1 V to 3.6 V		–	10	ns/V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. All unused inputs and I/O pins must be held at V_{CCI} or GND.

FXL2T245

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions	V _{CC0} (V)	V _{CCI} (V)	Min	Max	Unit
V _{IH}	HIGH Level Input (Note 5)	Data Inputs A _n , B _n	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 _{CCI}	–	
				1.40 to 1.65	0.65 x V _{CCI}	–	
				1.10 to 1.40	0.90 x V _{CCI}	–	
		Control Pins / \overline{OE} , T/ \overline{R} (Referenced to V _{CCA})		2.70 to 3.60	2.00	–	
				2.30 to 2.70	1.60	–	
				1.65 to 2.30	0.65 x V _{CCA}	–	
				1.40 to 1.65	0.65 x V _{CCA}	–	
				1.10 to 1.40	0.90 x V _{CCA}	–	
V _{IL}	LOW Level Input (Note 5)	Data Inputs A _n , B _n	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 _{CCI}	
				1.40 to 1.65	–	0.35 x V _{CCI}	
				1.10 to 1.40	–	0.10 x V _{CCI}	
		Control Pins / \overline{OE} , T/ \overline{R} (Referenced to V _{CCA})		2.70 to 3.60	–	0.80	
				2.30 to 2.70	–	0.70	
				1.65 to 2.30	–	0.35 x V _{CCI}	
				1.40 to 1.65	–	0.35 x V _{CCI}	
				1.10 to 1.40	–	0.10 x V _{CCI}	
V _{OH}	HIGH Level Output (Note 6)	I _{OH} = –100 μA	1.10 to 3.60	1.10 to 3.60	V _{CC0} – 0.20	–	V
		I _{OH} = –12 mA	2.70	2.70	2.20	–	
		I _{OH} = –18 mA	3.00	3.00	2.40	–	
		I _{OH} = –24 mA	3.00	3.00	2.20	–	
		I _{OH} = –6 mA	2.30	2.30	2.00	–	
		I _{OH} = –12 mA	2.30	2.30	1.80	–	
		I _{OH} = –18 mA	2.30	2.30	1.70	–	
		I _{OH} = –6 mA	1.65	1.65	1.25	–	
		I _{OH} = –2 mA	1.40	1.40	1.05	–	
		I _{OH} = –0.5 mA	1.10	1.10	0.75 x V _{CC0}	–	
V _{OL}	LOW Level Output (Note 6)	I _{OL} = 100 μA	1.10 to 3.60	1.10 to 3.60	–	0.20	V
		I _{OL} = 12 mA	2.70	2.70	–	0.40	
		I _{OL} = 18 mA	3.00	3.00	–	0.40	
		I _{OL} = 24 mA	3.00	3.00	–	0.55	
		I _{OL} = 12 mA	2.30	2.30	–	0.40	
		I _{OL} = 18 mA	2.30	2.30	–	0.60	
		I _{OL} = 6 mA	1.65	1.65	–	0.30	
		I _{OL} = 2 mA	1.40	1.40	–	0.35	
		I _{OL} = 0.5 mA	1.10	1.10	–	0.30 x V _{CC0}	
I _L	Input Leakage Current, Control Pins	V _I = V _{CCA} or GND	3.60	1.10 to 3.60	–	±1.0	μA

FXL2T245

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Conditions	V _{CCO} (V)	V _{CCI} (V)	Min	Max	Unit
I _{OFF}	Power Off Leakage Current	A _n , V _I or V _O = 0 V to 3.6 V	3.60	0	–	±10	μA
		B _n , V _I or V _O = 0 V to 3.6 V	0	3.60	–	±10	
I _{OZ}	3-State Output Leakage (0 ≤ V _O ≤ 3.6 V, V _I = V _{IH} or V _{IL})	A _n , B _n , /OE = V _{IH}	3.60	3.60	–	±10	μA
		B _n , /OE = Don't Care (Note 7)	3.60	0	–	±10	
		A _n , /OE = Don't Care (Note 7)	0	3.60	–	±10	
I _{CCA/B}	Quiescent Supply Current (Note 8)	V _I = V _{CCI} or GND; I _O = 0	1.10 to 3.60	1.10 to 3.60	–	20	μA
I _{CCZ}			1.10 to 3.60	1.10 to 3.60	–	20	μA
I _{CCA}		V _I =V _{CCA} or GND; I _O = 0	1.10 to 3.60	0	–	–10	μA
			0	1.10 to 3.60	–	10	
I _{CCB}		V _I = V _{CCB} or GND; I _O = 0	0	1.10 to 3.60	–	–10	μA
			1.10 to 3.60	0	–	10	
ΔI _{CCA/B}	Increase in I _{CC} per Input; Other Inputs at V _{CC} or GND	V _{IH} = 3.0 V	3.60	3.60	–	500	μA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

5. V_{CCI} = the V_{CC} associated with the data input under test.

6. V_{CCO} = the V_{CC} associated with the output under test.

7. Don't care = any valid logic level.

8. Reflects current per supply, V_{CCA} or V_{CCB}.

FXL2T245

AC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	T _A = −40 °C to +85 °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 1.3 V		
		Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Typ	

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

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 /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_{PHZ}, t_{PLZ}	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	

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

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 /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_{PHZ}, t_{PLZ}	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	

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

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 /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_{PHZ}, t_{PLZ}	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	

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

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	

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

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	$T_A = +25\text{ }^{\circ}\text{C}$	Unit
			Typical	
C_{IN}	Input Capacitance (Pins O/E, TR)	$V_{CCA} = V_{CCB} = 3.3\text{ V}, V_I = 0\text{ V}$ or $V_{CCA/B}$	4	pF
$C_{I/O}$	Input/Output Capacitance A_n, B_n Ports	$V_{CCA} = V_{CCB} = 3.3\text{ V}, V_I = 0\text{ V}$ or $V_{CCA/B}$	5	pF
C_{PD}	Power Dissipation Capacitance	$V_{CCA} = V_{CCB} = 3.3\text{ V}, V_I = 0\text{ V}$ or $V_{CC}, f = 10\text{ MHz}$	20	pF

AC LOADINGS AND WAVEFORMS

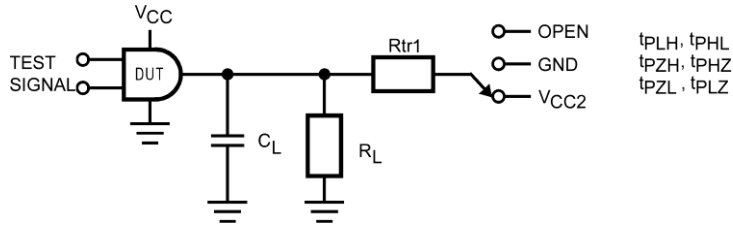
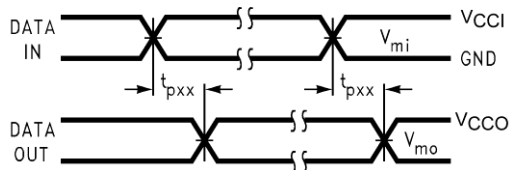


Figure 2. AC Test Circuit

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

Table 1. AC LOAD TABLE

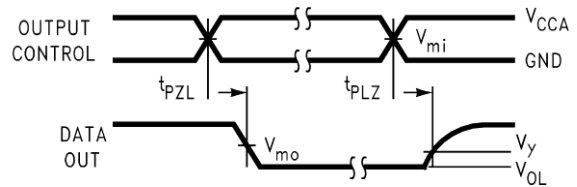
V_{CC0}	C_L	R_L	R_{tr1}
$1.2 \text{ V} \pm 0.1 \text{ V}$	15 pF	2 k Ω	2 k Ω
$1.5 \text{ V} \pm 0.1 \text{ V}$	15 pF	2 k Ω	2 k Ω
$1.8 \text{ V} \pm 0.15 \text{ V}$	15 pF	2 k Ω	2 k Ω
$2.5 \text{ V} \pm 0.2 \text{ V}$	15 pF	2 k Ω	2 k Ω
$3.3 \text{ V} \pm 0.3 \text{ V}$	15 pF	2 k Ω	2 k Ω



NOTES:

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

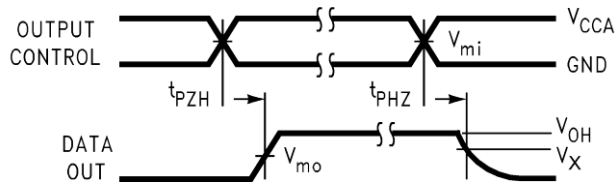
Figure 3. Waveform for Inverting and Non-Inverting Functions



NOTES:

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

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



NOTES:

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

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

FXL2T245

Symbol	V_{CC}				
	3.3 V ± 0.3 V	2.5 V ± 0.2 V	1.8 V ± 0.15 V	1.5 V ± 0.1 V	1.2 V ± 0.1 V
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	$V_{OH} - 0.3$ 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

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

ORDERING INFORMATION

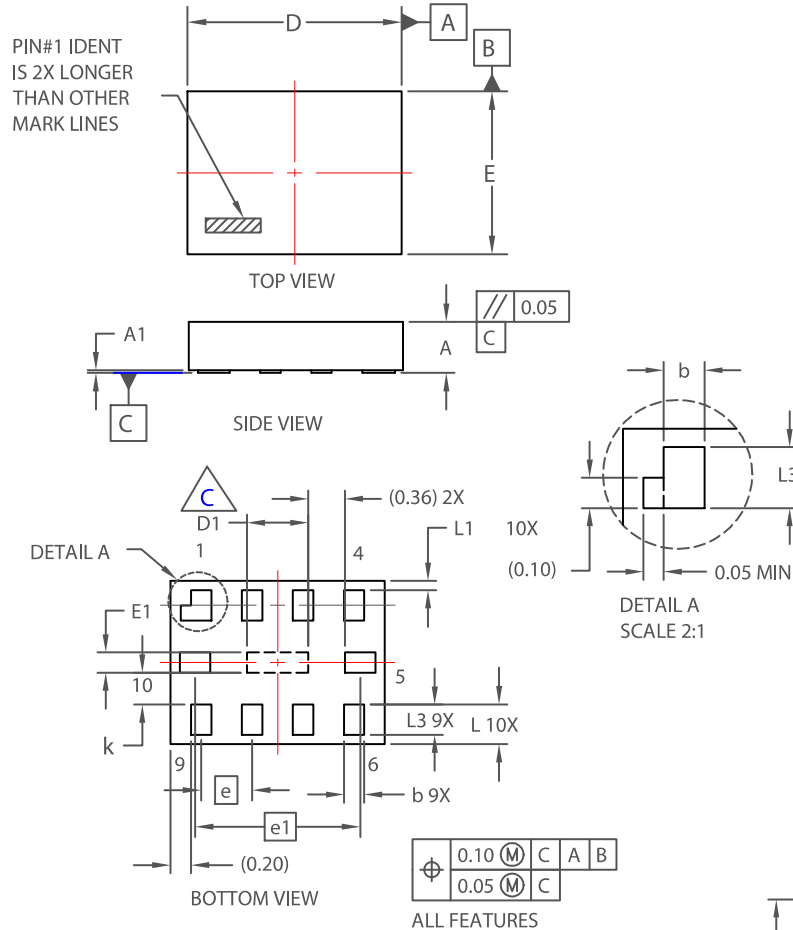
Part Number	Operating Temperature Range	Package Description	Shipping [†]
FXL2T245L10X	-40 °C to +85 °C	10-Lead, MicroPak, JEDEC MO255, 1.6 x 2.1 mm (Pb-Free, Halide Free)	5000 / Tape & Reel

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



UQFN10 (MICROPAK™), 1.6X2.1, 0.5P
CASE 523AZ
ISSUE A

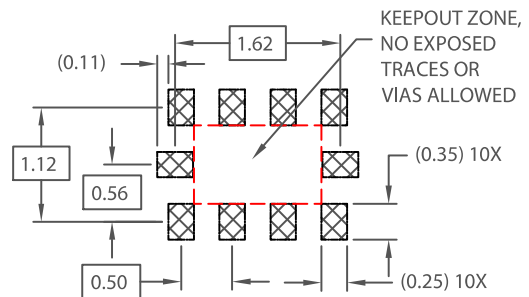
DATE 11 DEC 2019



NOTES:

- A. PACKAGE CONFORMS TO JEDEC REGISTRATION MO-255, VARIATION UABD.
B. DIMENSIONS ARE IN MILLIMETERS.
C. PRESENCE OF CENTER PAD IS PACKAGE SUPPLIER DEPENDENT. IF PRESENT IT IS NOT INTENDED TO BE SOLDERED AND HAS A BLACK OXIDE FINISH.
D. DIMENSIONS WITHIN () ARE UNCONTROLLED.

DIM	MIN.	NOM.	MAX.
A	0.50	0.55	0.65
A1	0.00	0.025	0.05
b	0.15	0.20	0.25
D	2.00	2.10	2.20
D1	0.55	0.60	0.65
E	1.50	1.60	1.70
E1	0.15	0.20	0.25
e	0.50 BSC		
e1	1.62 BSC		
k	0.20	--	--
L	0.25	0.30	0.42
L1	0.00	0.09	0.15
L3	0.25	0.30	0.35



**RECOMMENDED
MOUNTING FOOTPRINT ***

*FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERM/D.

DOCUMENT NUMBER:	98AON13592G	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	UQFN10 (MICROPAK™), 1.6X2.1, 0.5P	PAGE 1 OF 1

onsemi and onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at
www.onsemi.com/support/sales