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November 2013

FXLA0104
Low-Voltage Dual-Supply 4-Bit Voltage Translator with Configurable Voltage Supplies and Signal Levels, 3-State Outputs, and Auto Direction Sensing

Features

- Bi-Directional Interface between Two Levels: from 1.1 V to 3.6 V
- Fully Configurable: Inputs and Outputs Track V_{CC}
- Non-Preferential Power-Up; Either V_{CC} May Be Powered Up First
- Outputs Switch to 3-State if Either V_{CC} is at GND
- Power-Off Protection
- Bus-Hold on Data Inputs Eliminates the Need for Pull-Up Resistors; Do Not Use Pull-Up Resistors on A or B Ports
- Control Input (OE) Referenced to V_{CCA} Voltage
- Available in the 12-Lead, 1.7 mm x 2.0 mm UMLP Package
- Direction Control Not Necessary
- 100 Mbps Throughput when Translating Between 1.8 V and 2.5 V
- ESD Protection Exceeds:
  - 6 kV HBM (per JESD22-A114 & Mil Std 883e 3015.7)
  - 2 kV CDM (per ESD STM 5.3)

Applications

- Cell Phone, PDA, Digital Camera, Portable GPS

Description

The FXLA0104 is a configurable dual-voltage supply translator for both 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 three-state as long as either V_{CC}=0V, 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 OE input, when LOW, disables both the A and B ports by placing them in a 3-state condition. The OE input is supplied by V_{CCA}.

The FXLA0104 supports bi-directional translation without the need for a direction control pin. The two ports of the device have auto-direction sense capability. Either port may sense an input signal and transfer it as an output signal to the other port.

Ordering Information

Part Number	Operating Temperature Range	Top Mark	Package	Packing Method
FXLA0104QFX	-40 to 85°C	XU	12-Lead, 1.7 mm x 2.0 mm Ultrathin Molded Leadless Package (UMLP)	5000 Units Tape and Reel

Pin Configuration

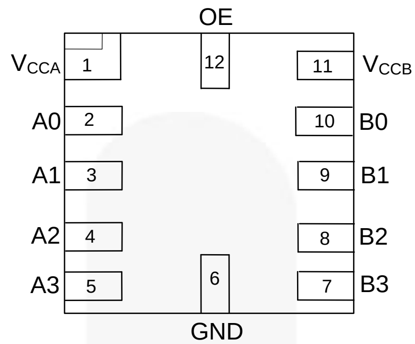


Figure 1. Top Through View

Pin Definitions

Pin #	Name	Description
1	V_{CCA}	A-Side Power Supply
2	A0	A-Side Inputs or 3-State Outputs
3	A1	A-Side Inputs or 3-State Outputs
4	A2	A-Side Inputs or 3-State Outputs
5	A3	A-Side Inputs or 3-State Outputs
6	GND	Ground
7	B3	B-Side Inputs or 3-State Outputs
8	B2	B-Side Inputs or 3-State Outputs
9	B1	B-Side Inputs or 3-State Outputs
10	B0	B-Side Inputs or 3-State Outputs
11	V_{CCB}	B-Side Power Supply
12	OE	Output Enable Input

Functional Diagram

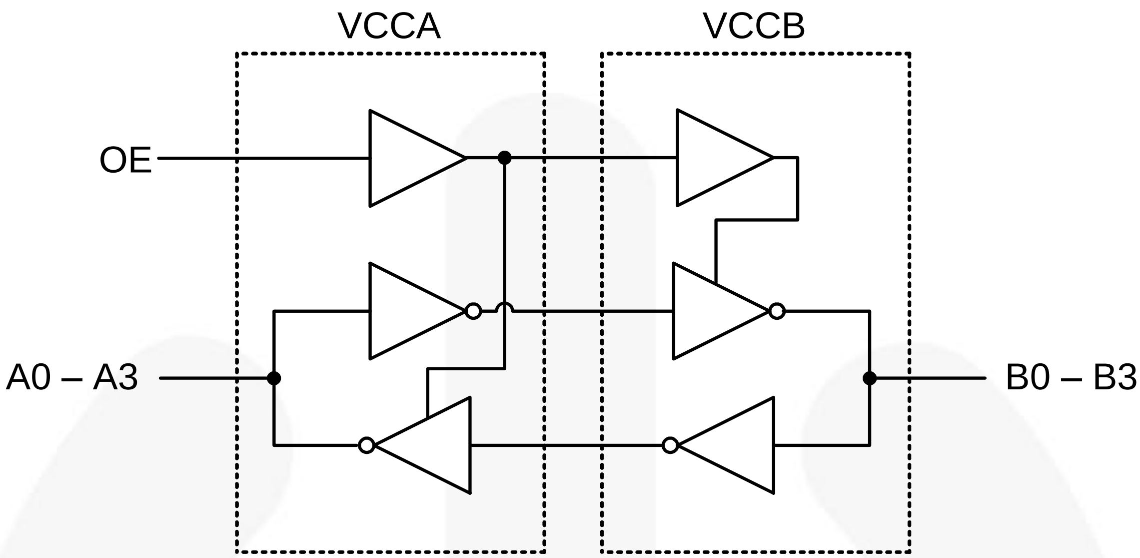


Figure 2. Functional Diagram

Function Table

Control	Outputs
OE	
LOW Logic Level	3-State
HIGH Logic Level	Normal Operation

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	Condition	Min.	Max.	Unit
V_{CC}	Supply Voltage	V_{CCA}	-0.5	4.6	V
		V_{CCB}	-0.5	4.6	
V_I	DC Input Voltage	I/O Ports A and B	-0.5	4.6	V
		Control Input (OE)	-0.5	4.6	
V_O	Output Voltage(2)	Output 3-State	-0.5	4.6	V
		Output Active (A_n)	-0.5	V_{CCA} +0.5	
		Output Active (B_n)	-0.5	V_{CCB} +0.5	
I_{IK}	DC Input Diode Current	V_{IN}<0V		-50	mA
I_{OK}	DC Output Diode Current	V_O<0V		-50	mA
		V_O>V_{CC}		+50	
I_{OH}/I_{OL}	DC Output Source/Sink Current		-50	+50	mA
I_{CC}	DC V_{CC} or Ground Current (per Supply Pin)			±100	mA
T_{STG}	Storage Temperature Range		-65	+150	°C
P_D	Power Dissipation			17	mW
ESD	Electrostatic Discharge Capability	Human Body Model (per JESD22-A114 & Mil Std 883e 3015.7)		6	kV
		Charged Device Model (per ESD STM 5.3)		2	

Notes:
1. I_O absolute maximum ratings must be observed.
2. All unused inputs and input/outputs must be held at V_{CCi} or GND.

Recommended Operating Conditions

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

Symbol	Parameter	Condition	Min.	Max.	Unit
V_{CC}	Power Supply	Operating V_{CCA} or V_{CCB}	1.1	3.6	V
V_{IN}	Input Voltage	Ports A and B	0	3.6	V
		Control Input (OE)	0	V_{CCA}	V
T_A	Operating Temperature, Free Air		-40	+85	°C
dt/dV	Minimum Input Edge Rate	$V_{CCA/B}$ = 1.1 to 3.6 V		10	ns/V
Θ_{JA}	Thermal Resistance: Junction-to-Ambient			300	°C/W
Θ_{JC}	Thermal Resistance: Junction-to-Case			165	°C/W

Power-Up/Power-Down Sequence

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 0V, outputs are in a high-impedance state. The control input (OE) is designed to track the V_{CCA} supply.

The recommended power-up sequence is:

1. Apply power to the first V_{CC}.
2. Apply power to the second V_{CC}.
3. Drive the OE input HIGH to enable the device.

The recommended power-down sequence is:

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

Pull-Up/Pull-Down Resistors

Do not use pull-up or pull-down resistors. This device has bus-hold circuits: pull-up or pull-down resistors are not recommended because they interfere with the output state. The current through these resistors may exceed the hold drive, $I_{I(HOLD)}$ and/or $I_{I(OD)}$ bus-hold currents, resulting in data transition and/or auto-direction sensing failures. The bus-hold feature eliminates the need for extra resistors.

DC Electrical Characteristics

T_A=-40 to 85°C

Symbol	Parameter	Condition	V_{CCA} (V)	V_{CCB} (V)	Min.	Typ.	Max.	Unit
V_{IHA}	High-Level Input Voltage	Data Inputs A_n Control Pin OE	2.70 to 3.60	1.10 to 3.60	2.00			V
			2.30 to 2.70		1.60			
			1.65 to 2.30		.65xV_{CCA}			
			1.40 to 1.65		.65xV_{CCA}			
			1.10 to 1.40		.90xV_{CCA}			
V_{IHB}		Data Inputs 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	.65xV_{CCB}			
				1.40 to 1.65	.65xV_{CCB}			
				1.10 to 1.40	.90xV_{CCB}			
V_{ILA}	Low-Level Input Voltage	Data Inputs A_n Control Pin OE	2.70 to 3.60	1.10 to 3.60			.80	V
			2.30 to 2.70				.70	
			1.65 to 2.30				.35xV_{CCA}	
			1.40 to 1.65				.35xV_{CCA}	
			1.10 to 1.40				.10xV_{CCA}	
V_{ILB}		Data Inputs B_n	1.10 to 3.60	2.70 to 3.60			.80	V
				2.30 to 2.70			.70	
				1.65 to 2.30			.35xV_{CCB}	
				1.40 to 1.65			.35xV_{CCB}	
				1.10 to 1.40			.10xV_{CCB}	
V_{OHA}	High-Level Output Voltage[3]	I_{OH}=-4 µA	1.10 to 3.60	1.10 to 3.60	V_{CCA} -.4			V
V_{OHB}		I_{OH}=-4 µA	1.10 to 3.60	1.10 to 3.60	V_{CCB} - .4			
V_{OLA}	Low-Level Output Voltage[3]	I_{OL}=4 µA	1.10 to 3.60	1.10 to 3.60			.4	V
V_{OLB}		I_{OL}=4 µA	1.10 to 3.60	1.10 to 3.60			.4	
$I_{I(HOLD)}$	Bus-Hold Input Minimum Drive Current	V_{IN}=0.8 V	3.00	3.00	75.0			µA
		V_{IN}=2.0 V	3.00	3.00	-75.0			
		V_{IN}=0.7 V	2.30	2.30	45.0			
		V_{IN}=1.6 V	2.30	2.30	-45.0			
		V_{IN}=0.57 V	1.65	1.65	25.0			
		V_{IN}=1.07 V	1.65	1.65	-25.0			
		V_{IN}=0.49 V	1.40	1.40	11.0			
		V_{IN}=0.91 V	1.40	1.40	-11.0			
		V_{IN}=0.11 V	1.10	1.10		4.0		
		V_{IN}=0.99 V	1.10	1.10		-4.0		

Note:

3. This is the output voltage for static conditions. Dynamic drive specifications are given in the Dynamic Output Electrical Characteristics table.

Continued on following page…

DC Electrical Characteristics (Continued)

T_A=-40 to 85°C.

Symbol	Parameter	Condition	V_{CCA} (V)	V_{CCB} (V)	Min.	Max.	Unit
$I_{I(ODH)}$	Bus-Hold Input Overdrive High Current(4)	Data Inputs A_n, B_n	3.60	3.60	450.0		µA
			2.70	2.70	300.0		
			1.95	1.95	200.0		
			1.60	1.60	120.0		
			1.40	1.40	80.0		
$I_{I(ODL)}$	Bus-Hold Input Overdrive Low Current(5)	Data Inputs A_n, B_n	3.60	3.60	-450.0		µA
			2.70	2.70	-300.0		
			1.95	1.95	-200.0		
			1.60	1.60	-120.0		
			1.40	1.40	-80.0		
I_I	Input Leakage Current	Control Inputs OE, V_I=V_{CCA} or GND	1.10 to 3.60	3.60		±1.0	µA
I_{OFF}	Power-Off Leakage Current	A_n V_O=0 V to 3.6 V	0	3.60		±2.0	µA
		B_n V_O=0 V to 3.6 V	3.60	0		±2.0	
I_{OZ}	3-State Output Leakage	A_n, B_n V_O=0 V or 3.6 V, OE=V_{IL}	3.60	3.60		±5.0	µA
		A_n V_O=0 V or 3.6 V, OE=V_{CCA}	3.60	0		±5.0	
		B_n V_O=0 V or 3.6 V, OE=3.6V	0	3.60		±5.0	
$I_{CCA/B}$	Quiescent Supply Current(6, 7)	V_I=V_{CCI} or GND; I_O=0, OE=V_{IH}	1.10 to 3.60	1.10 to 3.60		10.0	µA
I_{CCZ}		V_I=V_{CCI} or GND; I_O=0, OE=GND	1.10 to 3.60	1.10 to 3.60		10.0	µA
I_{CCA}	Quiescent Supply Current	V_I=V_{CCB} or GND; I_O=0 B-to-A Direction; OE=V_{IH}	0	1.10 to 3.60		-10.0	µA
		V_I=V_{CCA} or GND; I_O=0 A-to-B Direction	1.10 to 3.60	0		10.0	
I_{CCB}		V_I=V_{CCA} or GND; I_O=0, A-to-B Direction, OE=V_{IH}	1.10 to 3.60	0		-10.0	µA
		V_I=V_{CCB} or GND; I_O=0 B-to-A Direction	0	1.10 to 3.60		10.0	

Notes:

4. An external drive must source at least the specified current to switch LOW-to-HIGH.
5. An external drive must source at least the specified current to switch HIGH-to-LOW.
6. V_{CCI} is the V_{CC} associated with the input side.
7. Reflects current per supply, V_{CCA} or V_{CCB}.

Dynamic Output Electrical Characteristic

A Port (A_n)

Output Load: C_L=15 pF, $R_L \geq$ MΩ ($C_{I/O}$=4 pF), T_A=-40 to 85°C

Symbol	Parameter	V_{CCA}=3.0 V to 3.6 V		V_{CCA}=2.3 V to 2.7 V		V_{CCA}=1.65 V to 1.95 V		V_{CCA}=1.4 V to 1.6 V		V_{CCA}=1.1 V to 1.3 V	Unit
		Typ.	Max.	Typ.	Max.	Typ.	Max	Typ.	Max.	Typ.	
t_{rise}	Output Rise Time A Port(9)		3.0		3.5		4.0		5.0	7.5	ns
t_{fall}	Output Fall Time A Port(10)		3.0		3.5		4.0		5.0	7.5	ns
I_{OHD}	Dynamic Output Current High(9)	-11.4		-7.5		-4.7		-3.2		-1.7	mA
I_{OLD}	Dynamic Output Current Low(10)	+11.4		+7.5		+4.7		+3.2		+1.7	mA

B Port (B_n)

Output Load: C_L=15 pF, $R_L \geq$ MΩ ($C_{I/O}$=5 pF), T_A=-40 to 85°C

Symbol	Parameter	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	Unit
		Typ.	Max.	Typ.	Max.	Typ.	Max	Typ.	Max.	Typ.	
t_{rise}	Output Rise Time B Port(9)		3.0		3.5		4.0		5.0	7.5	ns
t_{fall}	Output Fall Time B Port(10)		3.0		3.5		4.0		5.0	7.5	ns
I_{OHD}	Dynamic Output Current High(9)	-12.0		-7.9		-5.0		-3.4		-1.8	mA
I_{OLD}	Dynamic Output Current Low(10)	+12.0		+7.9		+5.0		+3.4		+1.8	mA

Notes:

8. Dynamic output characteristics are guaranteed, but not tested.
9. *See Figure 7*.
10. *See Figure 8.*

AC Characteristics

V_{CCA} = 3.0 V to 3.6 V, T_A=-40 to 85°C

Symbol	Parameter	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	Unit
		Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.	Typ.	
t_{PLH},t_{PHL}	A to B	0.2	4.0	0.3	4.2	0.5	5.4	0.6	6.8	6.9	ns
	B to A	0.2	4.0	0.2	4.1	0.3	5.0	0.5	6.0	4.5	ns
t_{PZL},t_{PZH}	OE to A, OE to B		1.7		1.7		1.7		1.7	1.7	µs
t_{SKEW}	A Port, B Port(11)		0.5		0.5		0.5		1.0	1.0	ns

V_{CCA} = 2.3 V to 2.7 V, T_A=-40 to 85°C

Symbol	Parameter	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	Unit
		Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.	Typ.	
t_{PLH},t_{PHL}	A to B	0.2	4.1	0.4	4.5	0.5	5.6	0.8	6.9	7.0	ns
	B to A	0.3	4.2	0.4	4.5	0.5	5.5	0.5	6.5	4.8	ns
t_{PZL},t_{PZH}	OE to A, OE to B		1.7		1.7		1.7		1.7	1.7	µs
t_{SKEW}	A Port, B Port(11)		0.5		0.5		0.5		1.0	1.0	ns

V_{CCA} = 1.65 V to 1.95 V, T_A=-40 to 85°C

Symbol	Parameter	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	Unit
		Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.	Typ.	
t_{PLH},t_{PHL}	A to B	0.3	5.0	0.5	5.5	0.8	6.7	0.9	7.5	7.5	ns
	B to A	0.5	5.4	0.5	5.6	0.8	6.7	1.0	7.0	5.4	ns
t_{PZL},t_{PZH}	OE to A, OE to B		1.7		1.7		1.7		1.7	1.7	µs
t_{SKEW}	A Port, B Port(11)		0.5		0.5		0.5		1.0	1.0	ns

Note:

11. Skew is the variation of propagation delay between output signals and applies only to output signals on the same port (A_n or B_n) and switching with the same polarity (LOW-to-HIGH or HIGH-to-LOW) *(see Figure 10).* Skew is guaranteed, but not tested.

AC Characteristics (Continued)

V_{CCA} = 1.4 V to 1.6 V, T_A=-40 to 85°C

Symbol	Parameter	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	Unit
		Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.	Typ.	
t_{PLH},t_{PHL}	A to B	0.5	6.0	0.5	6.5	1.0	7.0	1.0	8.5	7.9	ns
	B to A	0.6	6.8	0.8	6.9	0.9	7.5	1.0	8.5	6.1	ns
t_{PZL},t_{PZH}	OE to A, OE to B		1.7		1.7		1.7		1.7	1.7	µs
t_{SKEW}	A Port, B Port(12)		1.0		1.0		1.0		1.0	1.0	ns

V_{CCA} = 1.1 V to 1.3 V, T_A=-40 to 85°C

Symbol	Parameter	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	Unit
		Typ.	Typ.	Typ.	Typ.	Typ.	
t_{PLH},t_{PHL}	A to B	4.6	4.8	5.4	6.2	9.2	ns
	B to A	6.8	7.0	7.4	7.8	9.1	ns
t_{PZL},t_{PZH}	OE to A, OE to B	1.7	1.7	1.7	1.7	1.7	µs
t_{SKEW}	A Port, B Port(12)	1.0	1.0	1.0	1.0	1.0	ns

Note:

12. Skew is the variation of propagation delay between output signals and applies only to output signals on the same port (A_n or B_n) and switching with the same polarity (LOW-to-HIGH or HIGH-to-LOW) *(see Figure 10).* Skew is guaranteed, but not tested.

Maximum Data Rate[13, 14]

T_A=-40 to 85°C

V_{CCA}	V_{CCB}=3.0 V to 3.6 V	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	Unit
	Min.	Min.	Min.	Min.	Typ.	
V_{CCA}=3.00 to 3.60 V	140	120	100	80	40	Mbps
V_{CCA}=2.30 to 2.70 V	120	120	100	80	40	Mbps
V_{CCA}=1.65 to 1.95 V	100	100	80	60	40	Mbps
V_{CCA}=1.40 to 1.60 V	80	80	60	60	40	Mbps
V_{CCA}=1.10 to 1.30 V	Typ.	Typ.	Typ.	Typ.	Typ.	
	40	40	40	40	40	Mbps

Notes:

13. Maximum data rate is guaranteed, but not tested.
14. Maximum data rate is specified in megabits per second *(see Figure 9)*. It is equivalent to two times the F-toggle frequency, specified in megahertz. For example, 100 Mbps is equivalent to 50MHz.

Capacitance

Symbol	Parameter		Conditions	T_A=+25°C Typical	Unit
C_{IN}	Input Capacitance Control Pin (OE)		V_{CCA}=V_{CCB}=GND	3	pF
$C_{I/O}$	Input/Output Capacitance	A_n	V_{CCA}=V_{CCB}=3.3 V, OE=GND	4	pF
		B_n		5	
C_{pd}	Power Dissipation Capacitance		V_{CCA}=V_{CCB}=3.3 V, V_I=0V or V_{CC}, f=10 MHz	25	pF

I/O Architecture Benefit

The FXLA0104 I/O architecture benefits the end user, beyond level translation, in the following three ways:

Auto Direction without an external direction pin.

Drive Capacitive Loads. Automatically shifts to a higher current drive mode only during "Dynamic Mode" or HL / LH transitions.

Lower Power Consumption. Automatically shifts to low-power mode during "Static Mode" (no transitions), lowering power consumption.

The FXLA0104 does not require a direction pin. Instead, the I/O architecture detects input transitions on both side and automatically transfers the data to the corresponding output. For example, for a given channel, if both A and B side are at a static LOW, the direction has been established as A → B, and a LH transition occurs on the B port; the FXLA0104 internal I/O architecture automatically changes direction from A → B to B → A.

During HL / LH transitions, or "Dynamic Mode," a strong output driver drives the output channel in parallel with a weak output driver. After a typical delay of approximately 10 ns – 50 ns, the strong driver is turned off, leaving the weak driver enabled for holding the logic state of the channel. This weak driver is called the "bus hold." "Static Mode" is when only the bus hold drives the channel. The bus hold can be over ridden in the event of a direction change. The strong driver allows the FXLA0104 to quickly charge and discharge capacitive transmission lines during dynamic mode. Static mode conserves power, where I_{CC} is typically < 5 µA.

Bus Hold Minimum Drive Current

Specifies the minimum amount of current the bus hold driver can source/sink. The bus hold minimum drive current (II_{HOLD}) is V_{CC} dependent and guaranteed in the DC Electrical tables. The intent is to maintain a valid output state in a static mode, but that can be overridden when an input data transition occurs.

Bus Hold Input Overdrive Drive Current

Specifies the minimum amount of current required (by an external device) to overdrive the bus hold in the event of a direction change. The bus hold overdrive (II_{ODH}, II_{ODL}) is V_{CC} dependent and guaranteed in the DC Electrical tables.

Dynamic Output Current

The strength of the output driver during LH / HL transitions is *referenced on page 8, Dynamic Output Electrical Characteristics, I_{OHD}, and I_{OLD}.*

Test Diagrams

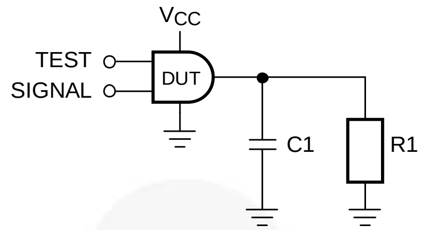


Figure 3. Test Circuit

Table 1. AC Test Conditions

Test	Input Signal	Output Enable Control
t_{PLH}, t_{PHL}	Data Pulses	VCCA
t_{PZL}	0V	LOW to HIGH Switch
t_{PZH}	V_{CCI}	LOW to HIGH Switch

Table 2. AC Load

V_{CCo}	C1	R1
1.2 V± 0.1 V	15 pF	1 MΩ
1.5 V± 0.1 V	15 pF	1 MΩ
1.8 V ± 0.15 V	15 pF	1 MΩ
2.5 V ± 0.2 V	15 pF	1 MΩ
3.3 V ± 0.3 V	15 pF	1 MΩ

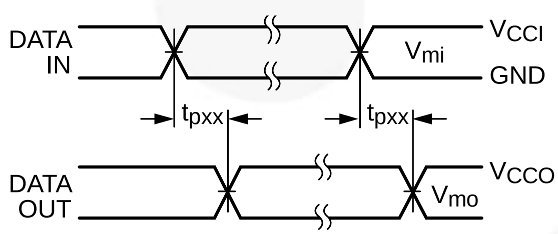


Figure 4. Waveform for Inverting and Non-Inverting Functions

Notes:

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

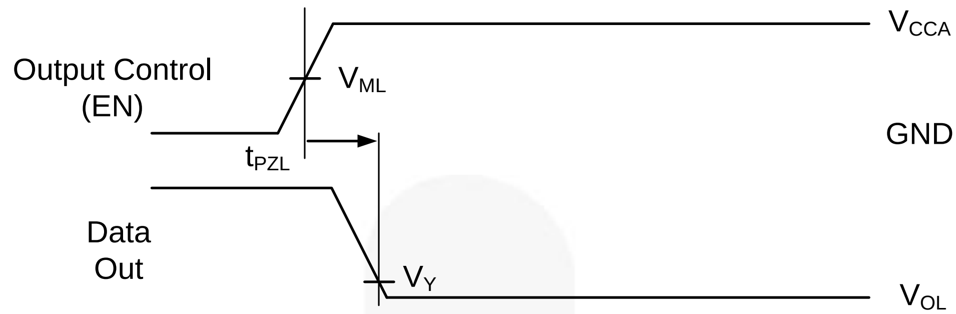


Figure 5. 3-State Output Low Enable

Notes:

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

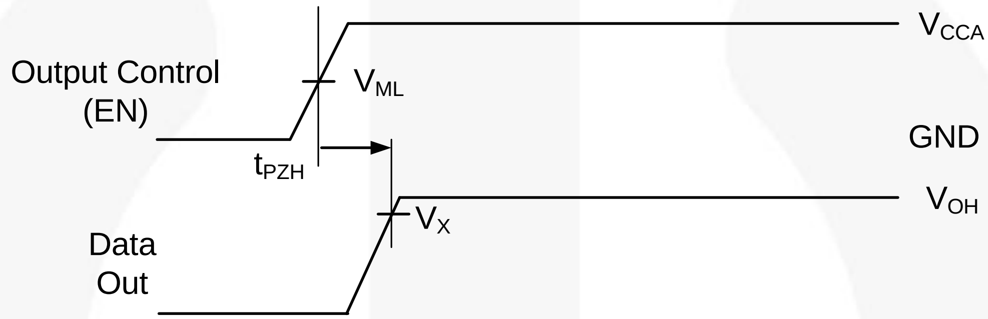


Figure 6. 3-State Output High Enable

Notes:

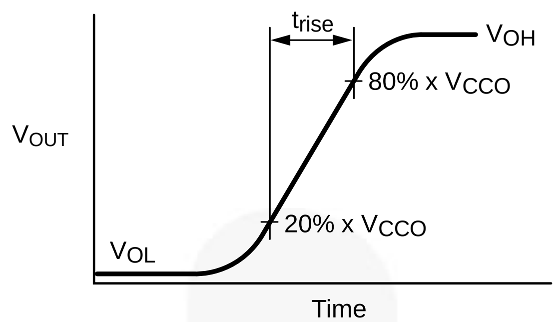
19. Input $t_R = t_F = 2.0$ ns, 10% to 90%.
20. Input $t_R = t_F = 2.5$ ns, 10% to 90%, at $V_I = 3.0$ V to 3.6 V only.

Table 3. Test Measure Points

Symbol	V_{DD}
V_{MI} (21)	V_{CCI} /2
V_{MO}	V_{CCo} /2
V_X	0.9 x V_{CCo}
V_Y	0.1 x V_{CCo}

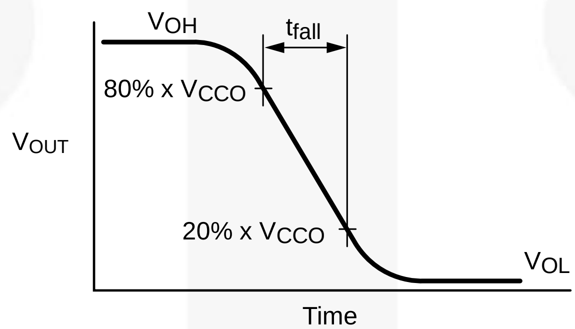
Note:

21. $V_{CCI}=V_{CCA}$ for control pin OE or $V_{MI}(V_{CCA}/2)$.



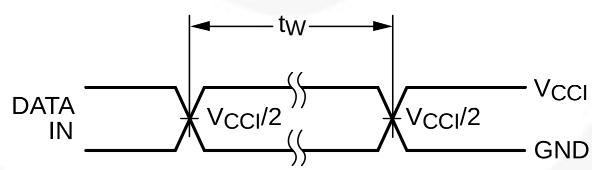
$$I_{OHD} \approx (C_L + C_{I/O}) \times \frac{\Delta V_{OUT}}{\Delta t} = (C_L + C_{I/O}) \times \frac{(20\% - 80\%) \bullet V_{CCO}}{t_{RISE}}$$

Figure 7. Active Output Rise Time and Dynamic Output Current High



$$I_{OLD} \approx (C_L + C_{I/O}) \times \frac{\Delta V_{OUT}}{\Delta t} = (C_L + C_{I/O}) \times \frac{(80\% - 20\%) \bullet V_{CCO}}{t_{FALL}}$$

Figure 8. Active Output Fall Time and Dynamic Output Current Low



Maximum Data Rate, $f = 1/t_W$

Figure 9. Maximum Data Rate

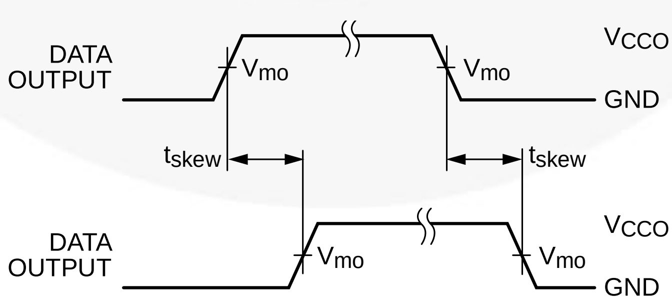


Figure 10. Output Skew Time

Note:

22. $t_{SKEW} = (t_{pHLmax} - t_{pHLmin})$ or $(t_{pLHmax} - t_{pLHmin})$

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