FAIRCHILD SEMICONDUCTOR®

October 2009

FXLA101
Low-Voltage Dual-Supply 1-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 1.1V to 3.6V
- Fully Configurable: Inputs and Outputs Track V_{CC}
- Non-Preferential Power-Up; 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
- Bus-Hold on Data Inputs Eliminates the Need for Pull-Up Resistors
- Control Input (/OE) Referenced to V_{CCA} Voltage
- Packaged in MicroPak™ 6 (1.00mm x 1.45mm)
- Direction Control Not Necessary
- 100Mbps Throughput when Translating Between 1.8V and 2.5V

Applications

- Cell Phones, PDAs, Digital Cameras, Portable GPS

Description

The FXLA101 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 3.6V 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 three-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 /OE input, when HIGH, disables both the A and B ports by placing them in a 3-state condition. The /OE input is supplied by V_{CCA}.

The FXLA101 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	Top Mark	Operating Temperature Range	Eco Status	Package	Packing Method
FXLA101L6X	XK	-40 to 85°C	Green	6-Lead MicroPak™ 1.00mm x 1.45mm Package	Tape and Reel
FXLA101FHX (Preliminary)	XK	-40 to 85°C	Green	6-Lead MicroPak2™ 1.0mm x 1.0mm Body, 0.35 Pitch Package	

For Fairchild's definition of Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs_green.html.

Pin Configuration

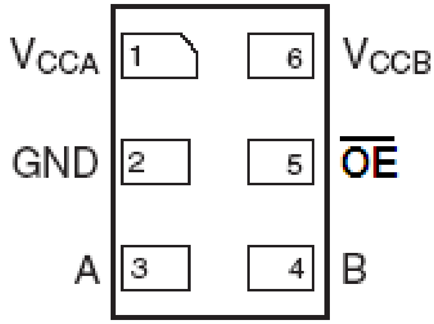

Figure 1. Pin Configuration (Top Through View)

Pin Definitions

Pin #	Name	Description
1	V_{CCA}	A-Side Power Supply
2	GND	Ground
3	A	A Side Input or 3-State Output
4	B	B Side Input or 3-State Output
5	/OE	Output Enable Input
6	V_{CCB}	B Side Power supply

Functional Diagram

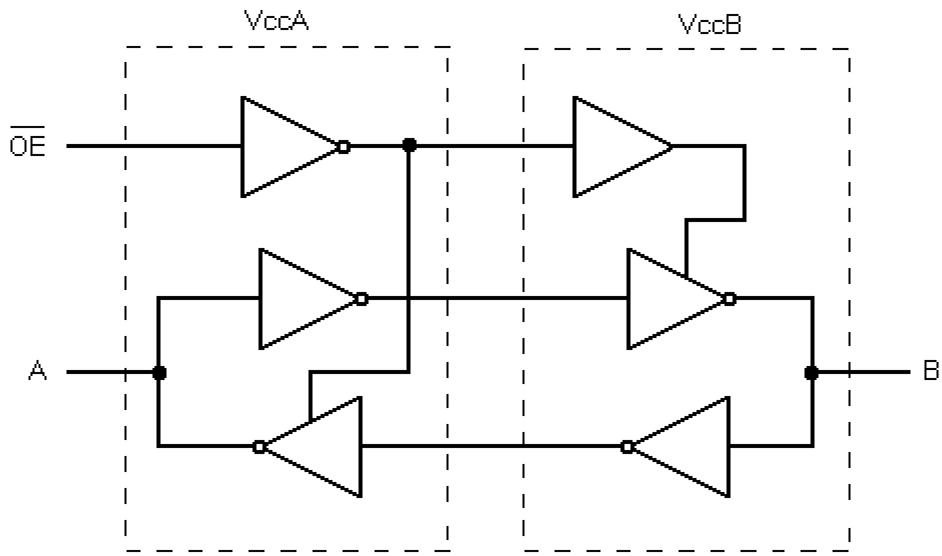

Figure 2. Functional Diagram

Function Table

Control	Outputs
/OE	
L	Normal Operation
H	3-State

H = HIGH Logic Level

L = LOW Logic Level

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_{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_I<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
ESD	Human Body Model, JESD22-A114	B Port I/O to GND		12000	V
		A Port I/O to GND		8000	
	Charged Device Model, JESD22-C101			2000	

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	Conditions	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 3.6V		10	ns/V

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. 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 or power-down. The size of the pull-up resistor is based upon the current-sinking capability of the device driving the /OE pin.

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 LOW to enable the device.

The recommended power-down sequence is:

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

DC Electrical Characteristics

T_A=-40 to 85°C.

Symbol	Parameter	Conditions	V_{CCA} (V)	V_{CCB} (V)	Min.	Typ.	Max.	Units
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	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		$.65xV_{CCB}$			
			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	2.70 to 3.60	1.10 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}=-4µA	1.10 to 3.60	1.10 to 3.60	V_{CCA} - .40			V
V_{OHB}		I_{OH}=-4µA	1.10 to 3.60	1.10 to 3.60	V_{CCB} - .40			
V_{OLA}	Low-Level Output Voltage[3]	I_{OL}=4µA	1.10 to 3.60	1.10 to 3.60			.4	V
V_{OLB}		I_{OL}=4µA	1.10 to 3.60	1.10 to 3.60			.4	
$I_{I(HOLD)}$	Bus-Hold Input Minimum Drive Current	V_{IN}=0.80V	3.00	3.00	75.0			µA
		V_{IN}=2.00V	3.00	3.00	-75.0			
		V_{IN}=0.7V	2.30	2.30	45.0			
		V_{IN}=1.60V	2.30	2.30	-45.0			
		V_{IN}=0.57V	1.65	1.65	25.0			
		V_{IN}=1.07V	1.65	1.65	-25.0			
		V_{IN}=0.49V	1.40	1.40	11.0			
		V_{IN}=0.91V	1.40	1.40	-11.0			
		V_{IN}=0.11V	1.10	1.10		4.0		
		V_{IN}=0.99V	1.10	1.10		-4.0		

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DC Electrical Characteristics (Continued)

T_A=-40 to 85°C.

Symbol	Parameter	Conditions	V_{CCA} (V)	V_{CCB} (V)	Min.	Max.	Units
$I_{I(ODH)}$	Bus-Hold Input Overdrive High Current[4]	Data Inputs A_n, B_n	3.60	3.60	450.00		µA
			2.70	2.70	300.00		
			1.95	1.95	200.00		
			1.60	1.60	120.00		
			1.40	1.40	80.00		
$I_{I(ODL)}$	Bus-Hold Input Overdrive Low Current[5]	Data Inputs A_n, B_n	3.60	3.60	-450.00		µA
			2.70	2.70	-300.00		
			1.95	1.95	-200.00		
			1.60	1.60	-120.00		
			1.40	1.40	-80.00		
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=0V to 3.6V	0	3.6		±2.0	µA
		B_n V_O=0V to 3.6V	3.60	0		±2.0	
I_{OZ}	3-State Output Leakage	A_n, B_n V_O=0V or 3.6V, /OE=V_{IH}	3.6	3.60		±5.0	µA
		A_n V_O=0V or 3.6V, /OE=GND	3.60	0		±5.0	
		B_n V_O=0V or 3.6V, /OE=GND	0	3.60		±5.0	
$I_{CCA/B}$	Quiescent Supply Current[6, 7]	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_{CCZ}		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_{CCA}	Quiescent Supply Current	V_I=V_{CCB} or GND; I_O=0 B-to-A Direction, /OE=GND	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=GND	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:

3. This is the output voltage for static conditions. Dynamic drive specifications are given in the Dynamic Output Electrical Characteristics table.
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=15pF, $R_L \geq$ MΩ ($C_{I/O}$=4pF), T_A=-40 to 85°C

Symbol	Parameter	V_{CCA}=3.0V to 3.6V		V_{CCA}=2.3V to 2.7V		V_{CCA}=1.65V to 1.95V		V_{CCA}=1.4V to 1.6V		V_{CCA}=1.1V to 1.3V	Units
		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=15pF, $R_L \geq$ MΩ ($C_{I/O}$=5pF), T_A=-40 to 85°C

Symbol	Parameter	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	Units
		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} = 3.0V to 3.6V, T_A=-40 to 85°C

Symbol	Parameter	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	Units
		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} = 2.3V to 2.7V, T_A=-40 to 85°C

Symbol	Parameter	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	Units
		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} = 1.65V to 1.95V, T_A=-40 to 85°C

Symbol	Parameter	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	Units
		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} = 1.4V to 1.6V, T_A=-40 to 85°C

Symbol	Parameter	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	Units
		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} = 1.1V to 1.3V, T_A=-40 to 85°C

Symbol	Parameter	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	Units
		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}=3.0V 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	Units
	Min.	**Min.**	**Min.**	**Min.**	**Typ.**	
V_{CCA}=3.00V to 3.60V	140	120	100	80	40	Mbps
V_{CCA}=2.30V to 2.70V	120	120	100	80	40	Mbps
V_{CCA}=1.65V to 1.95V	100	100	80	60	40	Mbps
V_{CCA}=1.40V to 1.60V	80	80	60	60	40	Mbps
V_{CCA}=1.10V to 1.30V	**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, 100Mbps is equivalent to 50MHz.

Capacitance

Symbol	Parameter		Conditions	T_A=+25°C Typical	Units
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}=3.3V, /OE=V_{CCA}	4	pF
		B_n		5	
C_{pd}	Power Dissipation Capacitance		V_{CCA}=V_{CCB}=3.3V, V_I=0V or V_{CC}, f=10MHz	25	pF

Test Diagrams

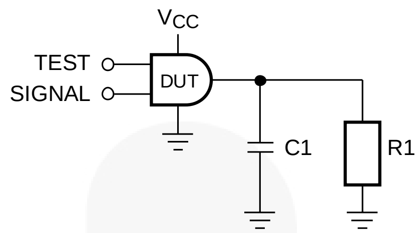


Figure 3. Test Circuit

Table 1. AC Test Conditions

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

Table 2. AC Load

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

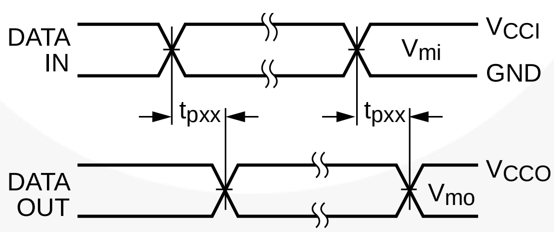


Figure 4. Waveform for Inverting and Non-Inverting Functions

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

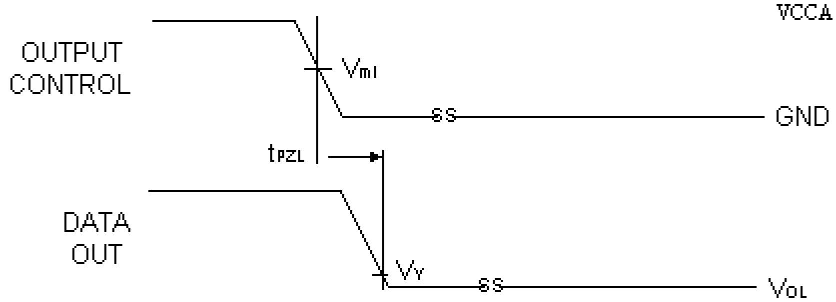


Figure 5. 3-State Output Low Enable Time for Low Voltage Logic

Notes:

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

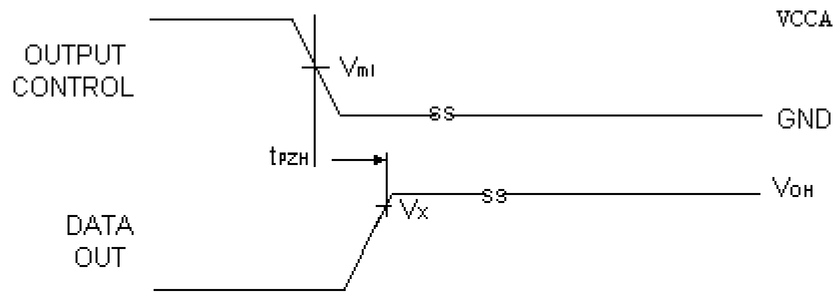


Figure 6. 3-State Output High Enable Time for Low Voltage Logic

Notes:

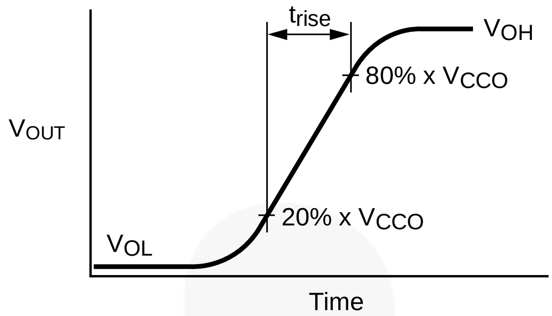
19. Input t_R = t_F = 2.0ns, 10% to 90%.
20. Input t_R = t_F = 2.5ns, 10% to 90%, at V_I = 3.0V to 3.6V only.

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}

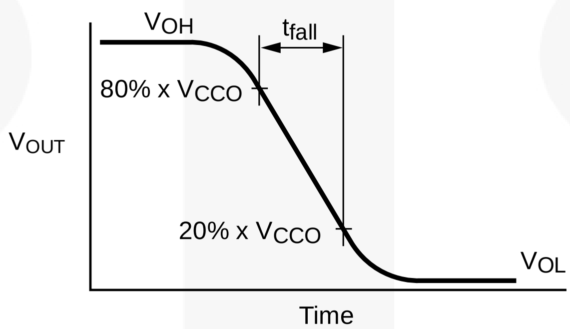
Note:

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

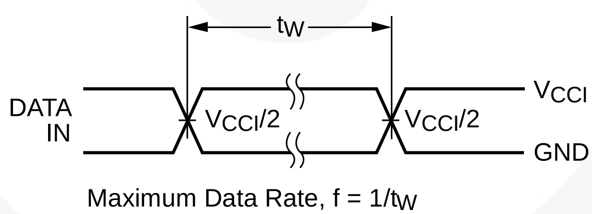


Figure 9. Maximum Data Rate

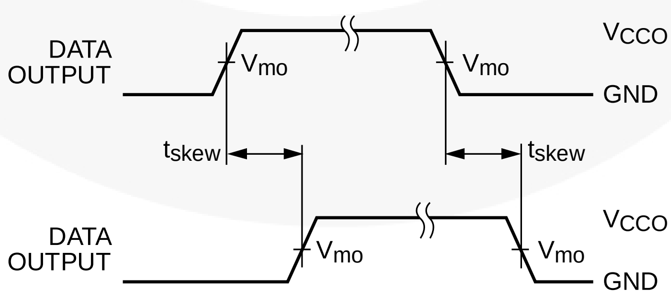
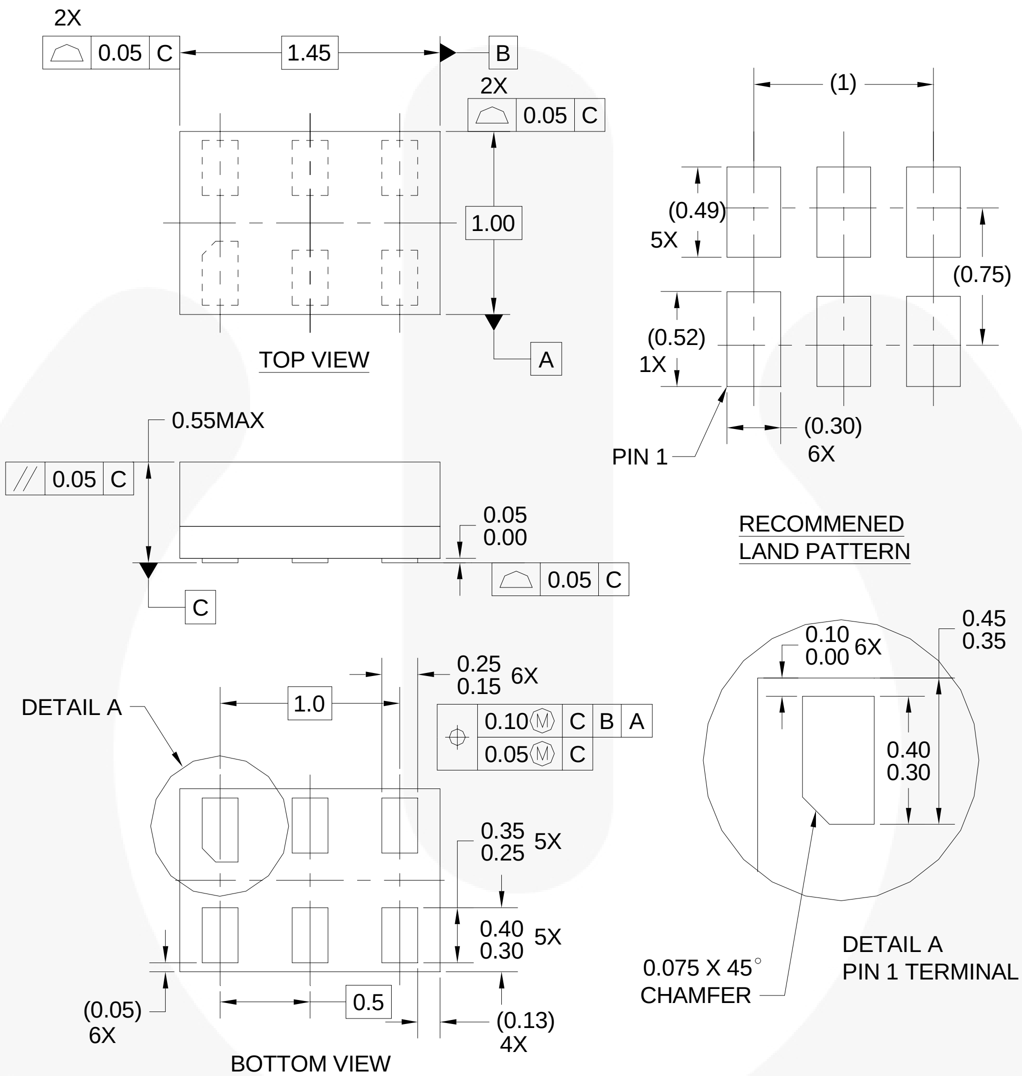


Figure 10. Output Skew Time

Note:

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

Physical Dimensions



Notes:

1. CONFORMS TO JEDEC STANDARD M0-252 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-1994

MAC06AREVC

Figure 11. 6-Lead MicroPak™ 1.00mm x 1.45mm Package

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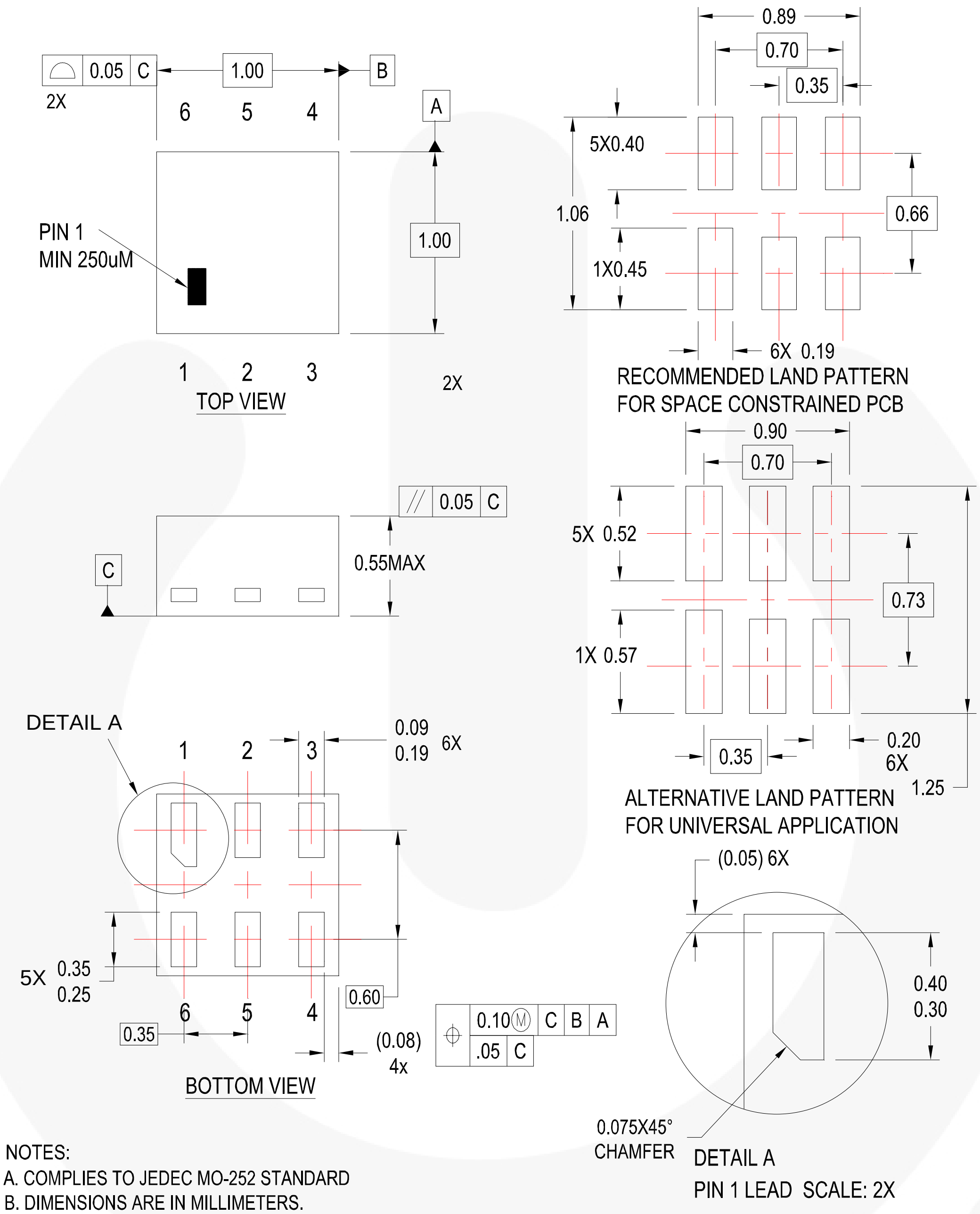
Physical Dimensions (Continued)



NOTES:
A. COMPLIES TO JEDEC MO-252 STANDARD
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994
D. LANDPATTERN RECOMMENDATION IS BASED ON FSC DESIGN ONLY
E. DRAWING FILENAME AND REVISION: MGF06AREV2

Figure 12. 6-Lead MicroPak2™ 1.0mm x 1.0mm Body, 0.35 Pitch Package

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