ⒶPERICOM®

PI4ULS3V08M

1.2V to 3.6V Universal Bi-directional Level Shifter with Automatic Direction Control & Advanced Package Solution

Features

- PI4ULS3V08M is designed for low voltage operation: 1.2V to 3.6V

- Universal bidirectional level shifting with automatic direction control

- Fast bus speeds up to 160 Mbps

- I_{OFF} supports partial Power-Down mode operation

- Drive Capability 12mA

- Independent translation of each bit

- Each supply rail is configurable over supply range

- ESD Protection exceeds JESD22
  – 2000V Human Body Model (A114-B)
  – 200V Machine Model (A115-A)

- Latch-up performance exceeds 100mA per JESD 78

- Industrial operation at –40°C to +85°C

- Packaging (Pb-free & Green):
  – 32-contact TQFN (ZL)

Applications
- Voltage Translation
- Bus Relay
- Mobile Devices
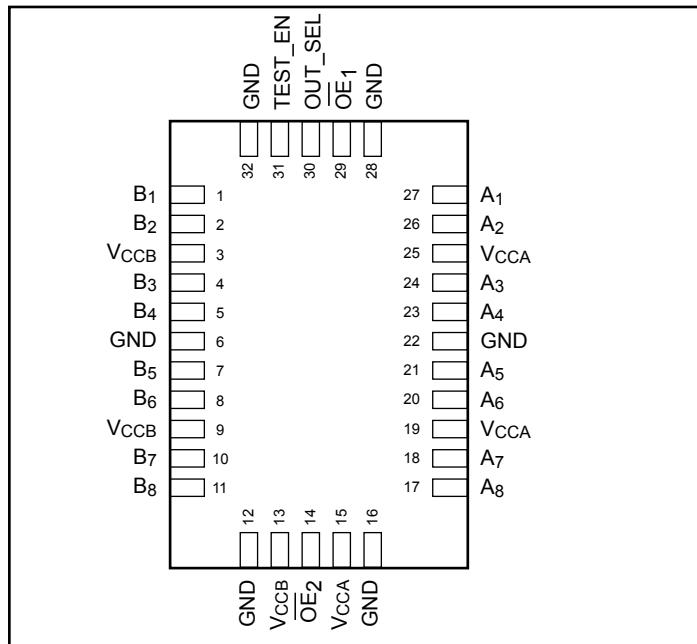
Description

PI4ULS3V08M, is a 8-bit (octal) non-inverting bus transceiver with two separate supply rails: A port (V_{CCA}) and B port (V_{CCB}) are set to operate at 1.2V to 3.6V. This arrangement permits universal bidirectional translation of differential signal levels over the voltage ranges.

The PI4ULS3V08M is designed for asynchronous communication between data buses. Data is transmitted from the A bus to the B bus, or vice versa, without direction control. All A_X, and B_X are tri-stated when data is coming from both directions at the same time. The output-enable ($\overline{OE}$) input is used to disable outputs so buses are isolated.

The control pins, OEx, TEST_EN and OUT_SEL are supplied by V_{CCB}.

The device is fully specified for partial-power-down applications using I_{OFF}. The I_{OFF} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

To ensure the high impedance state during power-up or power-down, the output-enable ($\overline{OEx}$) input should be tied to V_{CC} through a pullup resistor: the minimum value of the resistor is determined by the current-sinking capability of the driver.

Pin Configuration

Block Diagram
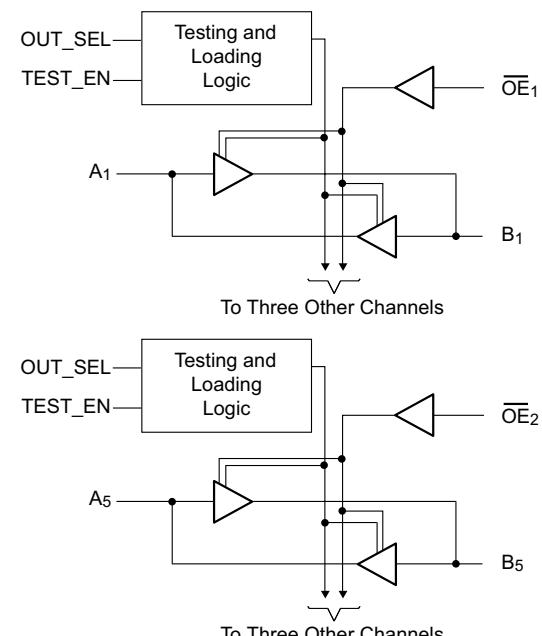
Maximum Ratings[3]

(Absolute maximum ratings over operating free-air temperature range, unless otherwise noted)

Supply voltage range: V_{CCA}.................... −0.5V to 4.6V	Input clamp current, I_{IK} (V_I <0).................................... −50mA
V_{CCB}.................... −0.5V to 4.6V	Output clamp current, I_{OK} (V_O <0)............................ −50mA
Input voltage range, V_I[1] Control Inputs...... −0.5V to 4.6V	Continuous output current, I_O .... ±20mA
Voltage Range applied to any I/O pins in the high-impedance or Power-Off state, V_{IO}[1] :	Continuous current through V_{CCA}, V_{CCB} or GND ..... ±100mA
A Port .... −0.5V to 4.6V	Storage temperature range, T_{STG} .... −65°C to 150°C
B Port................... −0.5V to 4.6V	
Voltage Range applied to any I/O pins in the High or Low state V_{IO} [1, 2]: A Port .... −0.5V to V_{CCA} +0.5V	
B Port.......−0.5V to V_{CCB} +0.5V	

Note:
1. The input negative voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 3.6V maximum.
3. Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Pin Description

Pin Name	Description
$\overline{OE}x$	3-State Output Enable Inputs (Active LOW)
A_X	Side A Inputs/Outputs
B_X	Side B Inputs/Outputs
TEST_EN	Enable Test Mode
OUT_SEL	Output impedance select
GND	Ground
$\overline{V_{CCA}}$, $\overline{V_{CCB}}$	Power

Truth Table[1]

Input $\overline{OE}x$	Outputs Loading	Operation
L	$C_L \leq 50pF$	Bus B data to bus A, or Bus A data to Bus B
H		Z (Isolation)

Note:
1. H = HIGH Signal Level
   L = LOW Signal Level
   Z = High Impedance

Test Mode / Output Impedance Select

TEST_EN	Out_SEL	Condition
L	L	Normal Operation Low output impedance 300Ω
L	H	Normal Operation High output impedance 2.2KΩ
H	L	Test_MODE A → B
H	H	Test_MODE B → A

Recommended Operating Conditions[1, 2, 3]

Parameter	Description		V_{CCI}	Min.	Max.	Units
V_{CCA}, V_{CCB}	Supply Voltage			1.2	3.6	V
V_{IH}	High-Level Input Voltage	I/O pins	1.2V to 1.95V	0.65 x V_{CCI}		
			2.3V to 2.7V	1.7		
			2.7V to 3.6V	2		
V_{IL}	Low-Level Input Voltage	I/O pins	1.2V to 1.95V		0.35 x V_{CCI}	
			2.3V to 2.7V		0.7	
			2.7V to 3.6V		0.8	
V_{IHB}	High-Level Input Voltage	Control Inputs ($\overline{OE}$)	1.2V to 1.95V	0.65 x V_{CCB}		
			2.3V to 2.7V	1.7		
			2.7V to 3.6V	2		
V_{ILB}	Low-Level Input Voltage	Control Inputs ($\overline{OE}$)	1.4V to 1.95V		0.35 x V_{CCB}	
			2.3V to 2.7V		0.7	
			2.7V to 3.6V		0.8	
V_I	Input Voltage	I/O pins and Control Inputs		0	3.6	
V_O	Output Voltage	I/O pins and Control Inputs		0	3.6	
I_{OH}	High-Level Output Current	I/O pins	V_{CCO} = 1.2V		-3	mA
			V_{CCO} = 1.4V		-5	
			V_{CCO} = 1.65V		-8	
			V_{CCO} = 2.3V		-9	
			V_{CCO} = 3.0V		-12	
I_{OL}	Low-Level Output Current	I/O pins	V_{CCO} = 1.2V		-3	
			V_{CCO} = 1.4V		5	
			V_{CCO} = 1.65V		8	
			V_{CCO} = 2.3V		9	
			V_{CCO} = 3.0V		12	
$\Delta V/\Delta t$	Input Transition rise or fall rate				10	V/ns
T_A	Operating Free-Air Temperature			-40	85	°C

Notes:
1. V_{CCI} is the V_{CC} associated with the data input port.
2. V_{CCO} is the V_{CC} associated with the data output port.
3. To ensure proper device operation, all unused device inputs must be held at V_{CCI} or GND.

Electrical Characteristics for (Over recommended free-air temperature range, unless otherwise noted.)[3]

Parameter	Description	Test Conditions	V_{CCA}/V_{CCB}	Min.	Typ. [1]	Max.	Units
V_{OH}	High-Level Output Voltage	$I_{OH} = -100\mu A$	1.2V to 3.6V	$V_{CCO} - 0.1V$			V
		$I_{OH} = -2mA$	1.2V		0.8		
		$I_{OH} = -4mA$	1.4V	1			
		$I_{OH} = -7mA$	1.65V	1.2			
		$I_{OH} = -9mA$	2.3V	1.8			
		$I_{OH} = -12mA$	3.0V	2.4			
V_{OL}	Low-Level Output Voltage	$I_{OL} = 100\mu A$	1.2V to 3.6V			0.2	
		$I_{OL} = 2mA$	1.2V		0.1		
		$I_{OL} = 4mA$	1.4V			0.4	
		$I_{OL} = 7mA$	1.65V			0.4	
		$I_{OL} = 9mA$	2.3V			0.4	
		$I_{OL} = 12mA$	3.0V			0.4	
I_{CC}	Quiescent Supply Current	$V_I = V_{CCI}$ or GND, $I_O = 0$	1.2V to 3.6V			10	μA
I_I	Control Inputs (OE and SEL)	$V_I = V_{CCB}$ or GND	1.2V to 3.6V			± 5	
I_{OZ}[2]	3-State Output Current	$V_O = V_{CCO}$ or GND	1.2V to 3.6V			± 10	
I_{OFF}	Power-off Leakage Current	V_I or V_O = 0 to 3.6V	0V			± 10	
C_{IN}	Control Input Capacitance	$V_I = V_{CCB}$ or GND			3		pF
C_{IO}	I/O Capacitance	$V_O = V_{CCA/B}$ or GND			5		

Notes:
1.   All typical values are at $T_A = 25°C$.
2.   For I/O ports, the parameter I_{OZ} includes the input leakage current.
3.   Parameters are specified under test mode conditions.

Timing Characteristics for V_{CCA} = 1.5V ±0.1V

(Over recommended free-air temperature range, unless otherwise noted.)

Parameter	From (Input)	To (Output)	V_{CCB} = 1.2V	V_{CCB} = 1.5V ±0.1V		V_{CCB} = 1.8V ±0.15V		V_{CCB} = 2.5V ±0.2V		V_{CCB} = 3.3V ±0.3V		Units
			Typ	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t_{PD}	A	B	8	1.0	7.0	1.0	6.5	1.0	6.0	1.0	5.0	ns
	B	A	6	1.0	7.0	1.0	6.5	1.0	6.0	1.0	5.5	
$t_{SK(a)}$[1]					0.3		0.3		0.3		0.3	
$t_{SK(b)}$[1]					0.25		0.25		0.25		0.25	
f_{max} 10pF load	B	A	12	15		20		22		25		MHz
	A	B	15	15		15		16		17		

Timing Characteristics for V_{CCA} = 1.8V ±0.15V

(Over recommended free-air temperature range, unless otherwise noted.)

Parameter	From (Input)	To (Output)	V_{CCB} = 1.2V	V_{CCB} = 1.5V ±0.1V		V_{CCB} = 1.8V ±0.15V		V_{CCB} = 2.5V ±0.2V		V_{CCB} = 3.3V ±0.3V		Units
			Typ	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t_{PD}	A	B	8	1.0	6.0	0.5	5.5	0.5	5.0	0.5	4.5	ns
	B	A	6	1.0	6.0	0.5	5.5	0.5	5.0	0.5	4.5	
$t_{SK(a)}$[1]					0.25		0.25		0.25		0.25	
$t_{SK(b)}$[1]					0.2		0.2		0.2		0.2	
f_{MAX} 10pF load	B	A	13	15		20		25		30		MHz
	A	B	16	20		20		22		24		

Timing Characteristics for V_{CCA} = 2.5V ±0.2V

(Over recommended free-air temperature range, unless otherwise noted.)

Parameter	From (Input)	To (Output)	V_{CCB} = 1.2V	V_{CCB} = 1.5V ±0.1V		V_{CCB} = 1.8V ±0.15V		V_{CCB} = 2.5V ±0.2V		V_{CCB} = 3.3V ±0.3V		Units
			Typ	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t_{PD}	A	B	8	1.0	5.5	0.5	5.0	0.5	4.5	0.5	4.0	ns
	B	A	6	1.0	5.5	0.5	5.0	0.5	4.5	0.5	4.0	
$t_{SK(a)}$[1]					0.25		0.25		0.25		0.25	
$t_{SK(b)}$[1]					0.2		0.2		0.2		0.2	
f_{max} 10pF load	B	A	13	15		22		35		40		MHz
	A	B	18	23		30		35		35		

Note:
1. This is the skew between any two outputs of the same package, and switching in the same direction. For $t_{SK(a)}$, Output 1 and Output 2 are any two outputs. For $t_{SK(b)}$, Output 1 and Output 2 are in the same bank. These parameters are warranted but not production tested.

Timing Characteristics for V_{CCA} = 3.3V ±0.3V
(Over recommended free-air temperature range, unless otherwise noted.)

Parameter	From (Input)	To (Output)	V_{CCA} = 1.2V	V_{CCB} = 1.5V ±0.1V		V_{CCB} = 1.8V ±0.15V		V_{CCB} = 2.5V ±0.2V		V_{CCB} = 3.3V ±0.3V		Units
			Typ.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t_{PD}	A	B		1.0	6.0	0.5	5.0	0.5	4.5	0.5	4.0	ns
	B	A		1.0	5.5	0.05	5.0	0.5	4.5	0.5	4.0	
$t_{SK(a)}$[1]					0.25		0.25		0.25		0.25	
$t_{SK(b)}$[1]					0.2		0.2		0.2		0.2	
f_{max} 10pF load	B	A	13	15		24		35		45		MHz
	A	B	15	25		30		40		45		

Notes:
1. This is the skew between any two outputs of the same package, and switching in the same direction. For $t_{SK(a)}$, Output 1 and Output 2 are any two outputs. For $t_{SK(b)}$, Output 1 and Output 2 are in the same bank. These parameters are warranted but not production tested.

Operating Characteristics (V_{CCA} and V_{CCB} = 2.5V, T_A = 25°C)

Parameter			Test Conditions	Typ.	Units
Cpd [1] (V_{CCA})	Power Dissipation Capacitance A to B	Outputs Enabled	C_L = 0 f = 10 MHz	15	pF
		Outputs Disabled		2	
	Power Dissipation Capacitance B to A	Outputs Enabled		30	
		Outputs Disabled		10	
Cpd [1] (V_{CCB})	Power Dissipation Capacitance A to B	Outputs Enabled	C_L = 0 f = 10 MHz	30	pF
		Outputs Disabled		10	
	Power Dissipation Capacitance B to A	Outputs Enabled		15	
		Outputs Disabled		2	

Notes:
1. This parameter is specified under test mode conditions.

Parameter Measurement Information

V_{CCA}/V_{CCB}	C_L
1.4V ~ 1.6V	10pF
1.8V ±0.15V	20pF
2.5V ±0.2V	30pF
3.3V ±0.3V	50pF

Test Circuit for t_{pd} / t_{sk}

Voltage Waveforms
**Propagation Delay Times**
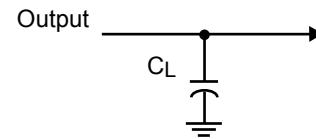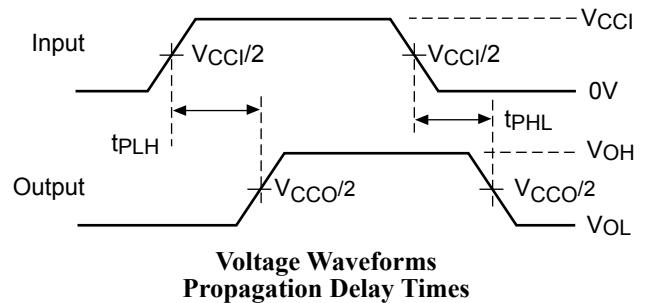
Figure 1. Load Circuit and Voltage Waveforms

Notes:
- C_L includes probe and jig capacitance.
- All input pulses are supplied by generators having the following characteristics: PRR ≤ 10Mz, $Z_O = 50\Omega$, tr ≤ 2.5ns, tf ≤ 2.5ns.
- The outputs are measured one at a time with one transition per measurement.
- V_{CCI} defines the input port (V_{CCA} or V_{CCB}).
- V_{CCO} defines the output port (V_{CCA} or V_{CCB}).

Packaging Mechanical: 32-contact TQFN
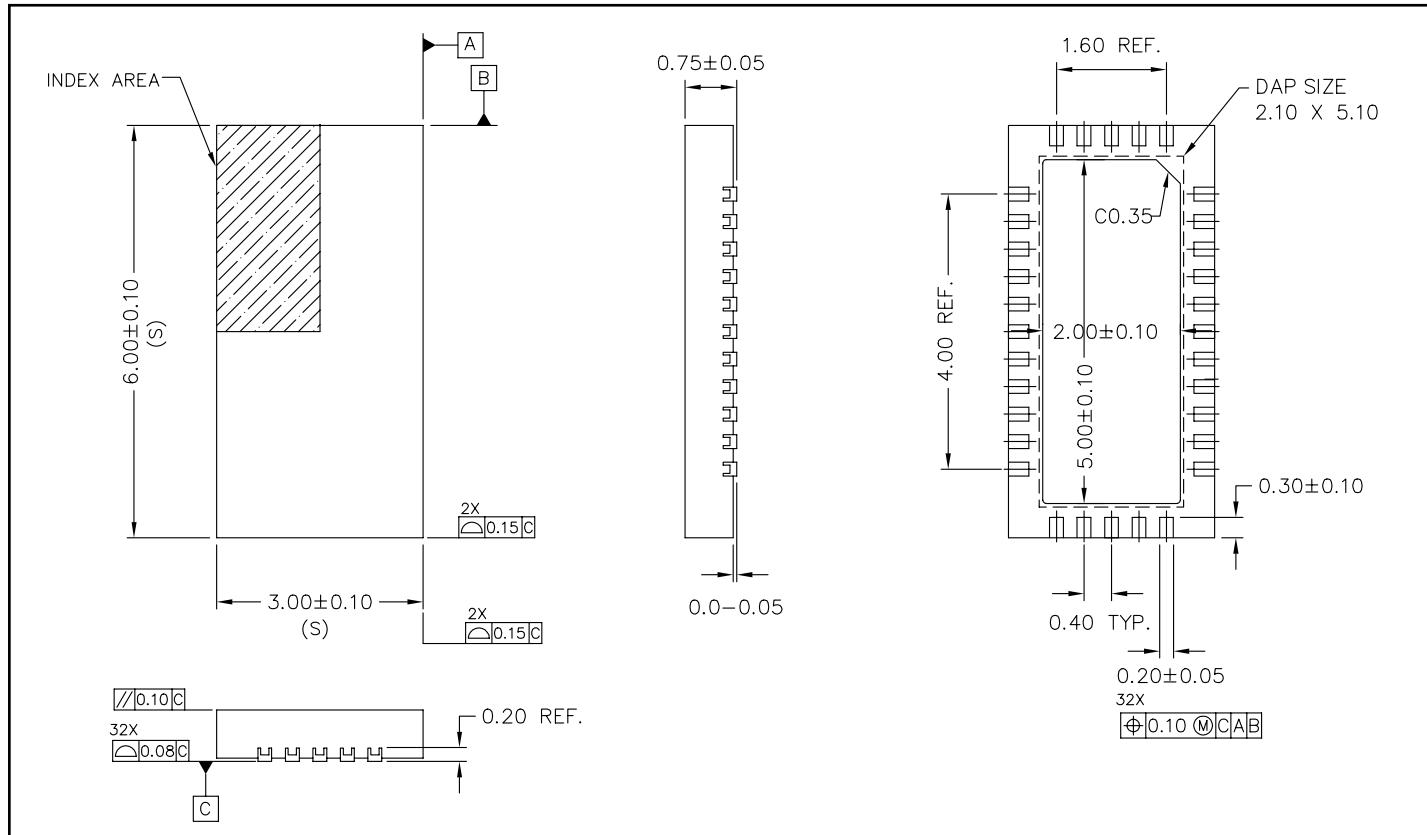
Ordering Information

Ordering Code	Packaging Code	Package Description
PI4ULS3V08MZLE	ZL	Pb-free & Green, 32-contact, TQFN

Notes:
- Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
- E = Pb-free and Green
- X Suffix = Tape/Reel