

**4-Bit Bi-directional Level Shifter for open-drain and Push-Pull Application**

**Features**

- $V_{CCA}$  can be Less than, Greater than or Equal to  $V_{CCB}$
- 1.1V to 3.6V on A Port and 1.1V to 3.6V on B Port
- High-Speed with 24 Mb/s Data Rate for push-pull application
- High-Speed with 2 Mb/s Data Rate for open-drain application
- No Direction-Control Signal Needed
- Low Bit-to-Bit Skew
- Non-preferential Power-up Sequencing
- ESD protection exceeds 8000V HBM per JESD22-A114
- Integrated 10 kΩ Pull-up Resistors
- Package: TSSOP-14, TQFN3.5x3.5-14, CSP-12

**Applications**

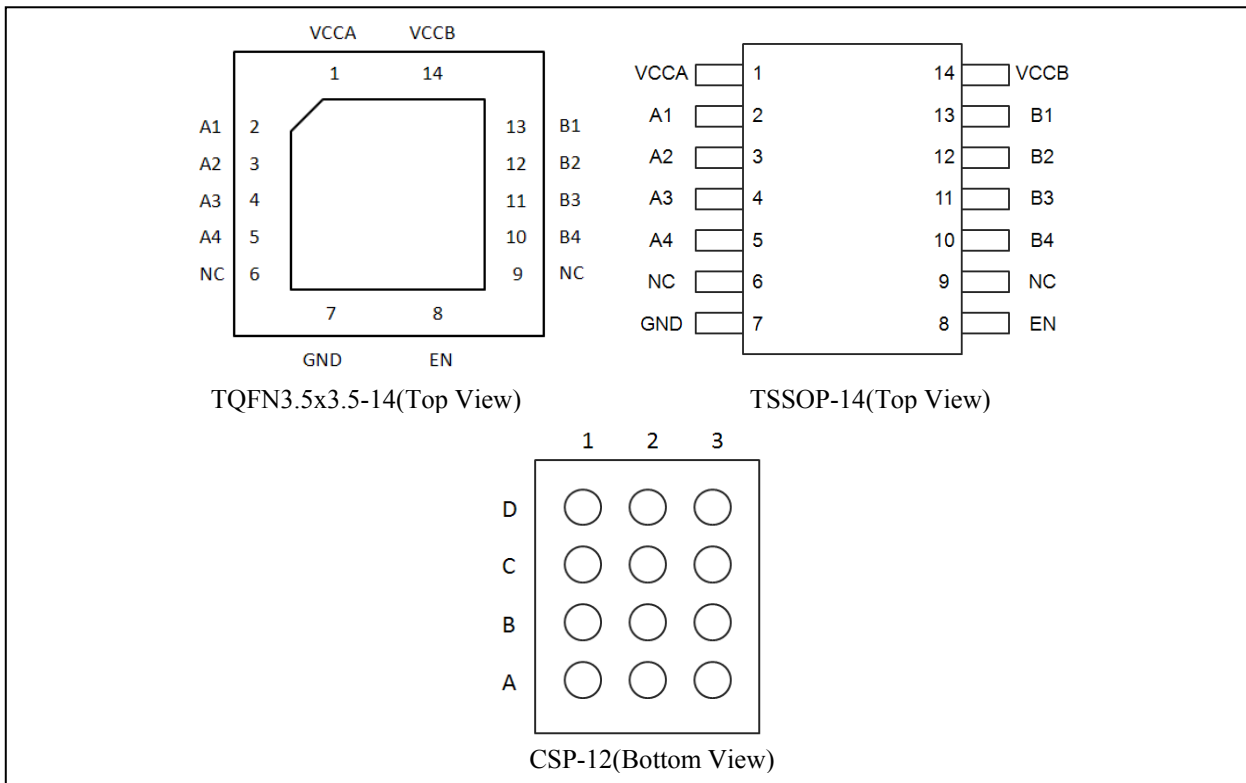
- I2C, SMBus, MDIO
- Low Voltage ASIC Level Translation
- Mobile Phones, PDAs, Camera

**Description**

The PI4ULS3V204 is a 4-bit configurable dual supply bidirectional auto sensing translator that does not require a directional control pin. The A and B ports are designed to track two different power supply rails,  $V_{CCA}$  and  $V_{CCB}$  respectively. Both the  $V_{CCA}$  and  $V_{CCB}$  supply rails are configurable from 1.1V to 3.6V. This allows voltage logic signals on the  $V_{CCA}$  side to be translated into lower, higher or equal value voltage logic signals on the  $V_{CCB}$  side, and vice-versa.

The translator has integrated 10 kΩ pull-up resistors on the I/O lines. The integrated pull-up resistors are used to pull-up the I/O lines to either  $V_{CCA}$  or  $V_{CCB}$ . The PI4ULS3V204 is an excellent match for open-drain applications such as the I2C communication bus.

**Pin Configuration**



**Block Diagram**

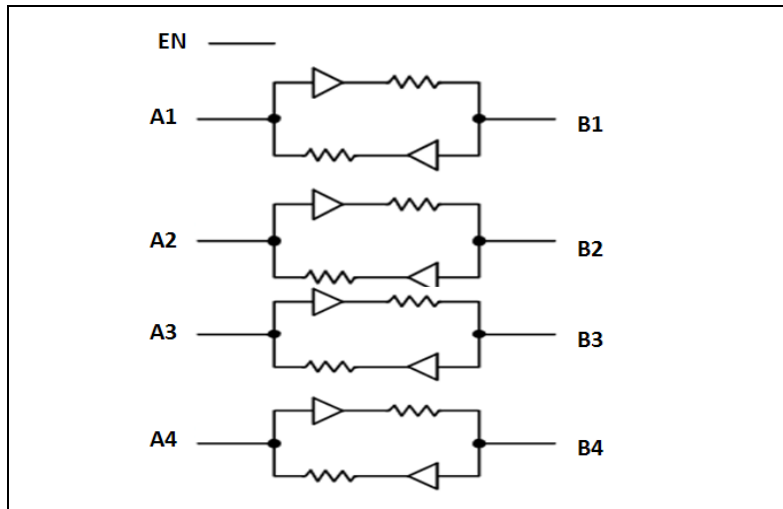


Figure 1: Block Diagram

**Maximum Ratings**

Storage Temperature.....	-65°C to +150°C
DC Supply Voltage port B.....	-0.3V to +5.5V
DC Supply Voltage port A.....	-0.3V to +5.5V
Vi(A) referenced DC Input / Output Voltage.....	-0.3V to +5.5V
Vi(B) referenced DC Input / Output Voltage.....	-0.3V to +5.5V
Enable Control Pin DC Input Voltage.....	-0.3V to +5.5V
Short circuit duration (I/O to GND).....	40mA

**Note:**

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 No TSSOP	Pin No TQFN	Pin No CSP	Pin Name	Type	Description
1	1	B2	V <sub>CCA</sub>	Power	A-port supply voltage. 1.1V ≤ V <sub>CCA</sub> ≤ 3.6 V
2	2	A3	A1	I/O	Input/output A. Referenced to V <sub>CCA</sub> .
3	3	B3	A2	I/O	Input/output A. Referenced to V <sub>CCA</sub>
4	4	C3	A3	I/O	Input/output A. Referenced to V <sub>CCA</sub>
5	5	D3	A4	I/O	Input/output A. Referenced to V <sub>CCA</sub>
7	7	D2	GND	GND	Ground.
8	8	C2	EN	Input	Output enable (active High). Pull EN low to place all outputs in 3-state mode.
10	10	D1	B4	I/O	Input/output B. Referenced to V <sub>CCB</sub>
11	11	C1	B3	I/O	Input/output B. Referenced to V <sub>CCB</sub>
12	12	B1	B2	I/O	Input/output B. Referenced to V <sub>CCB</sub>
13	13	A1	B1	I/O	Input/output B. Referenced to V <sub>CCB</sub>
14	14	A2	V <sub>CCB</sub>	Power	B-port supply voltage. 1.1 V ≤ V <sub>CCB</sub> ≤ 3.6V
6, 9	6, 9	/	NC	NC	Not Connect

## Recommended Operation Conditions

Symbol	Parameter	Min	Typ	Max	Unit
$V_{CCA}$	$V_{CCA}$ Positive DC Supply Voltage	1.1	-	3.6	V
$V_{CCB}$	$V_{CCB}$ Positive DC Supply Voltage	1.1	-	3.6	V
$V_{EN}$	Enable Control Pin Voltage	GND	-	3.6	V
$V_{IO}$	I/O Pin Voltage	GND	-	3.6	V
$\Delta t / \Delta V$	Input transition rise or fall time	-	-	10	ns/V
$T_A$	Operating Temperature Range	-40	-	+85	°C

## DC Electrical Characteristics

 Unless otherwise specified,  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ,  $1.1\text{V} \leq V_{CC} \leq 3.6\text{V}$ 

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit	
$V_{IHB}$	B port Input HIGH Voltage	$2.3\text{V} \leq V_{CC(B)} \leq 3.6\text{V}$	$V_{CCB} - 0.4$	-	-	V	
		$1.5\text{V} \leq V_{CC(B)} < 2.3\text{V}$	$V_{CCB} - 0.2$			V	
		$1.1\text{V} \leq V_{CC(B)} < 1.5\text{V}$	$V_{CCB} - 0.1$			V	
$V_{ILB}$	B port Input LOW Voltage			-	0.15	V	
$V_{IHA}$	A port Input HIGH Voltage	$2.3\text{V} \leq V_{CC(A)} \leq 3.6\text{V}$	$V_{CCA} - 0.4$			V	
		$1.5\text{V} \leq V_{CC(A)} < 2.3\text{V}$	$V_{CCA} - 0.2$			V	
		$1.1\text{V} \leq V_{CC(A)} < 1.5\text{V}$	$V_{CCA} - 0.1$			V	
$V_{ILA}$	A port Input LOW Voltage	-	-	-	0.15	V	
$V_{IH(EN)}$	Control Pin Input HIGH Voltage	$1.5\text{V} < V_{CC(A)} \leq 3.6\text{V}$	$0.65 * V_{CCA}$	-	-	V	
		$1.1\text{V} \leq V_{CC(A)} \leq 1.5\text{V}$	$0.6 * V_{CCA}$			V	
$V_{IL(EN)}$	Control Pin Input LOW Voltage	$1.5\text{V} < V_{CC(A)} \leq 3.6\text{V}$	-	-	$0.35 * V_{CCA}$	V	
		$1.1\text{V} \leq V_{CC(A)} \leq 1.5\text{V}$			$0.2 * V_{CCA}$	V	
$V_{OHB}$	B port Output HIGH Voltage	B port source current = $-20 \mu\text{A}$	$0.8 * V_{CCB}$	-	-	V	
$V_{OLB}$	B port Output LOW Voltage	B port sink current = $1 \text{mA}$	-	-	0.4	V	
$V_{OHA}$	A port Output HIGH Voltage	A port source current = $-20 \mu\text{A}$	$0.8 * V_{CCA}$	-	-	V	
$V_{OLA}$	A port Output LOW Voltage	A port sink current = $1 \text{mA}$	-	-	0.4	V	
$I_{CCB}$	$V_{CCB}$ Supply Current	$V_I = V_{CCI};$ $I_O = 0\text{A};$ EN = Low or High	$V_{CC(A)} = 1.1\text{V to } 3.6\text{V},$ $V_{CC(B)} = 1.1\text{V to } 3.6\text{V}$	-	1.0	3	$\mu\text{A}$
			$V_{CCA} = 1.1\text{V}, V_{CCB} = 1.8\text{V}$	-	0.6	2	$\mu\text{A}$
			$V_{CCA} = 1.8\text{V}, V_{CCB} = 3.3\text{V}$	-	0.7	2	$\mu\text{A}$
			$V_{CC(A)} = 3.6\text{V}, V_{CC(B)} = 0\text{V}$	-		1	$\mu\text{A}$
			$V_{CC(A)} = 0\text{V}, V_{CC(B)} = 3.6\text{V}$	-		1	$\mu\text{A}$
$I_{CCA}$	$V_{CCA}$ Supply Current	$V_I = V_{CCI};$ $I_O = 0\text{A};$ EN = Low or High	$V_{CC(A)} = 1.1\text{V to } 3.6\text{V},$ $V_{CC(B)} = 1.1\text{V to } 3.6\text{V}$	-	0.2	1	$\mu\text{A}$
			$V_{CC(A)} = 3.6\text{V}, V_{CC(B)} = 0\text{V}$	-	-	1	$\mu\text{A}$
			$V_{CC(A)} = 0\text{V}, V_{CC(B)} = 3.6\text{V}$	-	-	1	$\mu\text{A}$
$I_{OZ}$	I/O Tri-state Output Mode Leakage Current	-	-	0.1	1.0	$\mu\text{A}$	
$I_{I-EN}$	Control pin leakage Current	$V_I = V_{CCI}$ or GND	-	-	1	$\mu\text{A}$	
$R_{PU}$	Pull-Up Resistors I/O A and B	-	-	10	-	$\text{k}\Omega$	
$C_i$	EN	$V_{CC(A)} = 3.3\text{V}, V_{CC(B)} = 3.3\text{V}$	-	-	0.5	pF	
$C_{iO}$	A port	$V_{CC(A)} = 3.3\text{V}, V_{CC(B)} = 3.3\text{V}$	-	-	5	pF	
	B port	$V_{CC(A)} = 3.3\text{V}, V_{CC(B)} = 3.3\text{V}$	-	-	5	pF	

**Note:** All units are production tested at  $T_A = +25^{\circ}\text{C}$ . Limits over the operating temperature range are guaranteed by design.

 Typical values are for  $V_{CCB} = +2.8 \text{V}$ ,  $V_{CCA} = +1.8 \text{V}$  and  $T_A = +25^{\circ}\text{C}$ .

## AC Electrical Characteristics

**Timing Characteristics – Rail-to-Rail Driving Configuration** (I/O test circuits of Figures 2, 3 and 7,  $C_{LOAD} = 15 \text{ pF}$ , driver output impedance  $\leq 50\Omega$ ,  $R_{LOAD} = 1 \text{ M}\Omega$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ , unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b><math>V_{CCA} = 1.2\text{V} \pm 0.1\text{V}</math>, <math>V_{CCB} = 1.8\text{V} \pm 0.15\text{V}</math></b>						
$t_{RB}$	B port Rise Time	-			20	nS
$t_{FB}$	B port Fall Time	-			25	nS
$t_{RA}$	A port Rise Time	-			20	nS
$t_{FA}$	A port Fall Time	-			20	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			200	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			9	nS
$t_{PLH-A-B}$		-			11	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			9	nS
$t_{PLH-B-A}$		-			10	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			20	Mbps
<b><math>V_{CCA} = 1.2\text{V} \pm 0.1\text{V}</math>, <math>V_{CCB} = 2.5\text{V} \pm 0.2\text{V}</math></b>						
$t_{RB}$	B port Rise Time	-			12	nS
$t_{FB}$	B port Fall Time	-			14	nS
$t_{RA}$	A port Rise Time	-			20	nS
$t_{FA}$	A port Fall Time	-			25	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			200	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			9	nS
$t_{PLH-A-B}$		-			11	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			9	nS
$t_{PLH-B-A}$		-			10	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			20	Mbps
<b><math>V_{CCA} = 1.2\text{V} \pm 0.1\text{V}</math>, <math>V_{CCB} = 3.3\text{V} \pm 0.3\text{V}</math></b>						
$t_{RB}$	B port Rise Time	-			12	nS
$t_{FB}$	B port Fall Time	-			18	nS
$t_{RA}$	A port Rise Time	-			16	nS
$t_{FA}$	A port Fall Time	-			30	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			200	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			8	nS
$t_{PLH-A-B}$		-			11	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			8	nS
$t_{PLH-B-A}$		-			10	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			20	Mbps

**AC Electrical Characteristics (Cont..)**

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b><math>V_{CCA} = 1.8V \pm 0.15V</math>, <math>V_{CCB} = 1.2V \pm 0.1V</math></b>						
$t_{RB}$	B port Rise Time	-			25	nS
$t_{FB}$	B port Fall Time	-			25	nS
$t_{RA}$	A port Rise Time	-			14	nS
$t_{FA}$	A port Fall Time	-			25	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			200	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			10	nS
$t_{PLH-A-B}$		-			15	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			12	nS
$t_{PLH-B-A}$		-			12	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			20	Mbps
<b><math>V_{CCA} = 1.8V \pm 0.15V</math>, <math>V_{CCB} = 2.5V \pm 0.2V</math></b>						
$t_{RB}$	B port Rise Time	-			8	nS
$t_{FB}$	B port Fall Time	-			8	nS
$t_{RA}$	A port Rise Time	-			6	nS
$t_{FA}$	A port Fall Time	-			12	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			150	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			5	nS
$t_{PLH-A-B}$		-			4	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			4	nS
$t_{PLH-B-A}$		-			4	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			24	Mbps
<b><math>V_{CCA} = 1.8V \pm 0.15V</math>, <math>V_{CCB} = 3.3V \pm 0.3V</math></b>						
$t_{RB}$	B port Rise Time	-			8	nS
$t_{FB}$	B port Fall Time	-			8	nS
$t_{RA}$	A port Rise Time	-			4	nS
$t_{FA}$	A port Fall Time	-			10	nS
$t_{EN}$	Enable Time	-			180	nS
$t_{DIS}$	Disable Time	-			120	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			6	nS
$t_{PLH-A-B}$		-			4	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			4	nS
$t_{PLH-B-A}$		-			4	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			24	Mbps

**AC Electrical Characteristics (Cont..)**

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b><math>V_{CCA} = 2.5V \pm 0.2V</math>, <math>V_{CCB} = 1.2V \pm 0.1V</math></b>						
$t_{RB}$	B port Rise Time	-			25	nS
$t_{FB}$	B port Fall Time	-			30	nS
$t_{RA}$	A port Rise Time	-			12	nS
$t_{FA}$	A port Fall Time	-			30	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			180	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			10	nS
$t_{PLH-A-B}$		-			14	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			20	nS
$t_{PLH-B-A}$		-			12	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			20	Mbps
<b><math>V_{CCA} = 2.5V \pm 0.2V</math>, <math>V_{CCB} = 1.8V \pm 0.15V</math></b>						
$t_{RB}$	B port Rise Time	-			8	nS
$t_{FB}$	B port Fall Time	-			9	nS
$t_{RA}$	A port Rise Time	-			9	nS
$t_{FA}$	A port Fall Time	-			9	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			120	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			3	nS
$t_{PLH-A-B}$		-			2	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			5	nS
$t_{PLH-B-A}$		-			5	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			24	Mbps
<b><math>V_{CCA} = 2.5V \pm 0.2V</math>, <math>V_{CCB} = 3.3V \pm 0.3V</math></b>						
$t_{RB}$	B port Rise Time	-			7	nS
$t_{FB}$	B port Fall Time	-			8	nS
$t_{RA}$	A port Rise Time	-			4	nS
$t_{FA}$	A port Fall Time	-			10	nS
$t_{EN}$	Enable Time	-			200	nS
$t_{DIS}$	Disable Time	-			120	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			3	nS
$t_{PLH-A-B}$		-			5	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			4	nS
$t_{PLH-B-A}$		-			4	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			24	Mbps

**AC Electrical Characteristics (Cont..)**

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b><math>V_{CCA} = 3.3V \pm 0.3V, V_{CCB} = 1.2V \pm 0.1V</math></b>						
$t_{RB}$	B port Rise Time	-			26	nS
$t_{FB}$	B port Fall Time	-			32	nS
$t_{RA}$	A port Rise Time	-			12	nS
$t_{FA}$	A port Fall Time	-			40	nS
$t_{EN}$	Enable Time	-			120	nS
$t_{DIS}$	Disable Time	-			300	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			10	nS
$t_{PLH-A-B}$		-			14	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			25	nS
$t_{PLH-B-A}$		-			12	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			20	Mbps
<b><math>V_{CCA} = 3.3V \pm 0.3V, V_{CCB} = 1.8V \pm 0.15V</math></b>						
$t_{RB}$	B port Rise Time	-			6	nS
$t_{FB}$	B port Fall Time	-			11	nS
$t_{RA}$	A port Rise Time	-			6	nS
$t_{FA}$	A port Fall Time	-			7	nS
$t_{EN}$	Enable Time	-			120	nS
$t_{DIS}$	Disable Time	-			200	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			4	nS
$t_{PLH-A-B}$		-			4	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			5	nS
$t_{PLH-B-A}$		-			5	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			24	Mbps
<b><math>V_{CCA} = 3.3V \pm 0.3V, V_{CCB} = 2.5V \pm 0.2V</math></b>						
$t_{RB}$	B port Rise Time	-			6	nS
$t_{FB}$	B port Fall Time	-			10	nS
$t_{RA}$	A port Rise Time	-			6	nS
$t_{FA}$	A port Fall Time	-			7	nS
$t_{EN}$	Enable Time	-			120	nS
$t_{DIS}$	Disable Time	-			200	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-			4	nS
$t_{PLH-A-B}$		-			4	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-			4	nS
$t_{PLH-B-A}$		-			4	nS
$t_{PPSKEW}$	Part-to-Part Skew	-			1	nS
MDR	Maximum Data Rate	-			24	Mbps

**Timing Characteristics – Open Drain Driving Configuration**

( $1.1 \leq V_{CCA} \leq V_{CCB} \leq 3.6V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$ )

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{RB}$	B port Rise Time	-	-	-	300	nS
$t_{FB}$	B port Fall Time	-	-	-	30	nS
$t_{RA}$	A port Rise Time	-	-	-	300	nS
$t_{FA}$	A port Fall Time	-	-	-	30	nS
$t_{PHL-A-B}$	Propagation Delay (Driving A)	-	-	-	20	nS
$t_{PLH-A-B}$		-	-	-	260	nS
$t_{PHL-B-A}$	Propagation Delay (Driving B)	-	-	-	20	nS
$t_{PLH-B-A}$		-	-	-	260	nS
$t_{PPSKEW}$	Part-to-Part Skew	-	-	-	1	nS
MDR	Maximum Data Rate	-	2	-	-	Mbps

**Test Circuits**

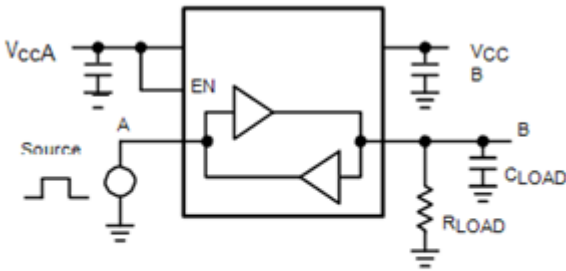


Figure 2. Rail-to-Rail Driving A

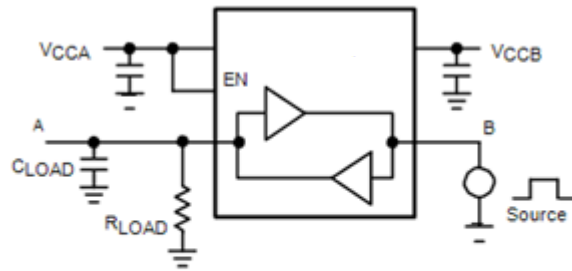


Figure 3. Rail-to-Rail Driving B

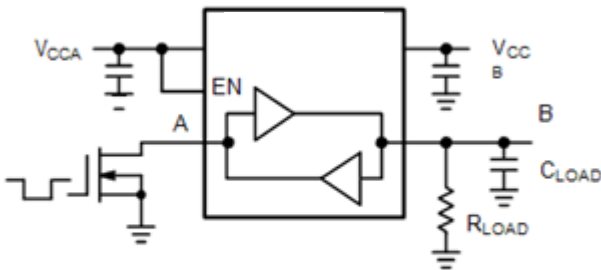


Figure 4. Open-Drain Driving A

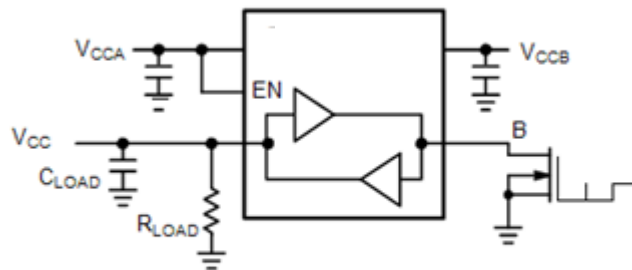


Figure 5. Open-Drain Driving B



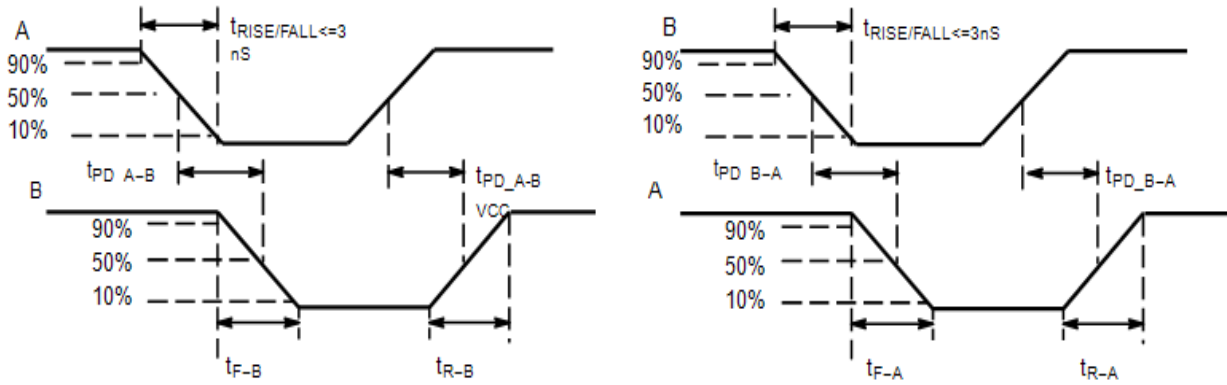
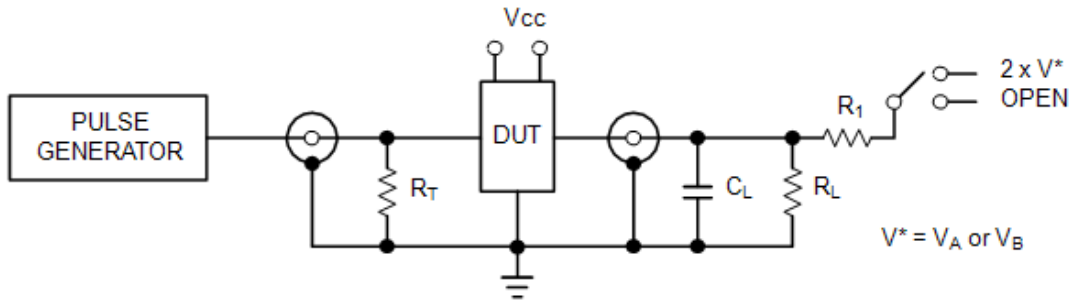


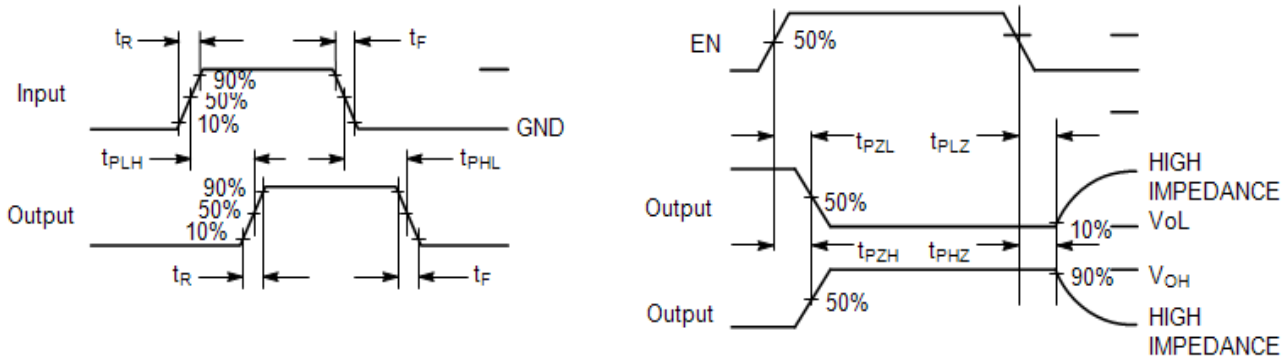
Figure 6. Definition of Timing Specification Parameters



Test	Switch
$t_{PZH}, t_{PHZ}$	Open
$t_{PZL}, t_{PLZ}$	$2 \times V^*$

$C_L = 15 \text{ pF}$  or equivalent (Includes jig and probe capacitance)  
 $R_L = R_1 = 50 \text{ k}\Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50 \Omega$ )  
 $V^* = V_A$  or  $V_B$  for A or B measurements, respectively.

Figure 7. Test Circuit for Enable/Disable Time Measurement



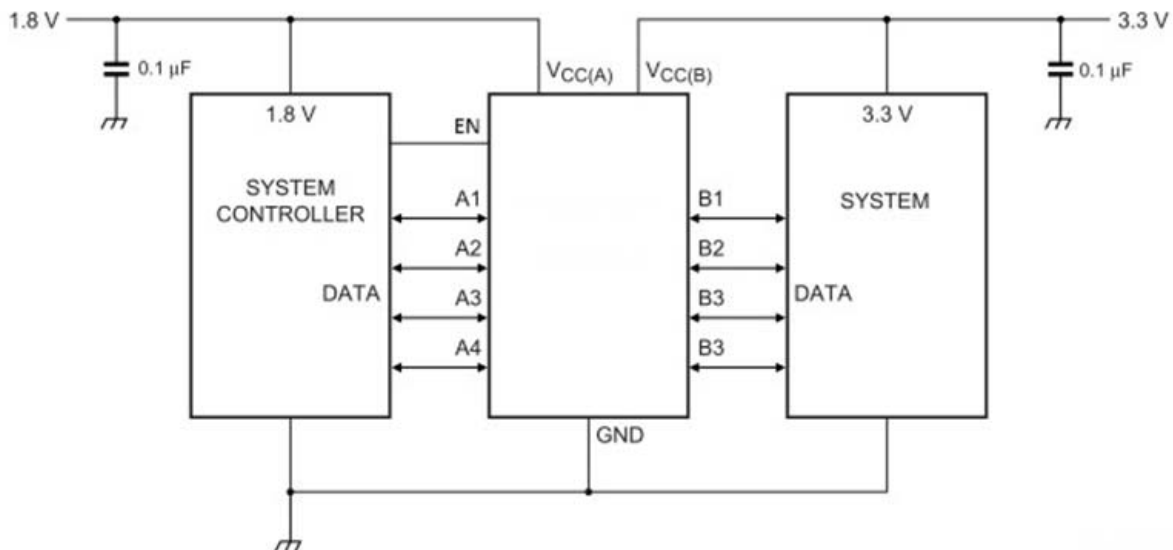
**Figure 8. Timing Definitions for Propagation Delays and Enable/Disable Measurement**

## Functional Description

The PI4ULS3V204 is a 4-bit configurable dual-supply bidirectional auto sensing translator that does not require a directional control pin. The A and B ports are designed to track two different power supply rails,  $V_{CCA}$  and  $V_{CCB}$  respectively. Both the  $V_{CCA}$  and  $V_{CCB}$  supply rails are configurable from 1.1 V to 3.6V. This allows voltage logic signals on the  $V_{CCA}$  side to be translated into lower, higher or equal value voltage logic signals on the  $V_{CCB}$  side, and vice-versa.

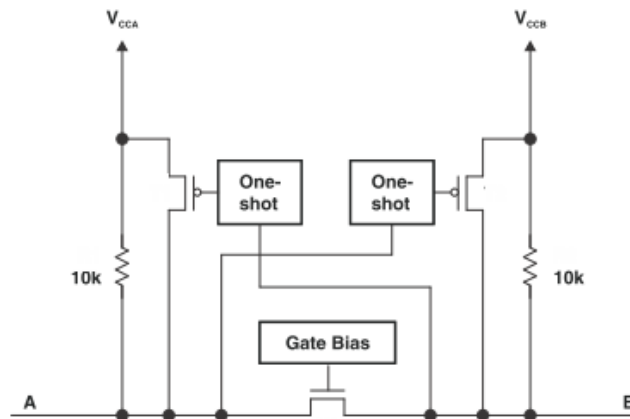
The translator has integrated 10 k $\Omega$  pull-up resistors on the I/O lines. The integrated pull-up resistors are used to pull-up the I/O lines to either  $V_{CCA}$  or  $V_{CCB}$ . The PI4ULS3V204 is an excellent match for open-drain applications such as the I<sup>2</sup>C communication bus.

## Application Information



## Level Translator Architecture

The PI4ULS3V204 auto sense translator provides bidirectional voltage level shifting to transfer data in multiple supply voltage systems. This device has two supply voltages,  $V_{CCA}$  and  $V_{CCB}$ , which set the logic levels on the input and output sides of the translator. When used to transfer data from A port to B port, input signals referenced to the  $V_{CCA}$  supply are translated to output signals with a logic level matched to  $V_{CCB}$ . In a similar manner, translation shifts input signals with a logic level compatible to  $V_{CCB}$  to an output signal matched to  $V_{CCA}$ . The PI4ULS3V204 consists of two bidirectional channels that independently determine the direction of the data flow without requiring a directional pin. The one-shot circuits are used to detect the rising or falling input signals. In addition, the one shots decrease the rise and fall time of the output signal for high-to-low and low-to-high transitions. Each input/output channel has an internal 10 k $\Omega$  pull. The magnitude of the pull-up resistors can be reduced by connecting external resistors in parallel to the internal 10 k $\Omega$  resistors.



### Input Driver Requirements

The rise (tR) and fall (tF) timing parameters of the open drain outputs depend on the magnitude of the pull-up resistors. In-addition, the propagation times (tPD), skew (tPSKEW) and maximum data rate depend on the impedance of the device that is connected to the translator. The timing parameters listed in the data sheet assume that the output impedance of the drivers connected to the translator is less than 50 kΩ.

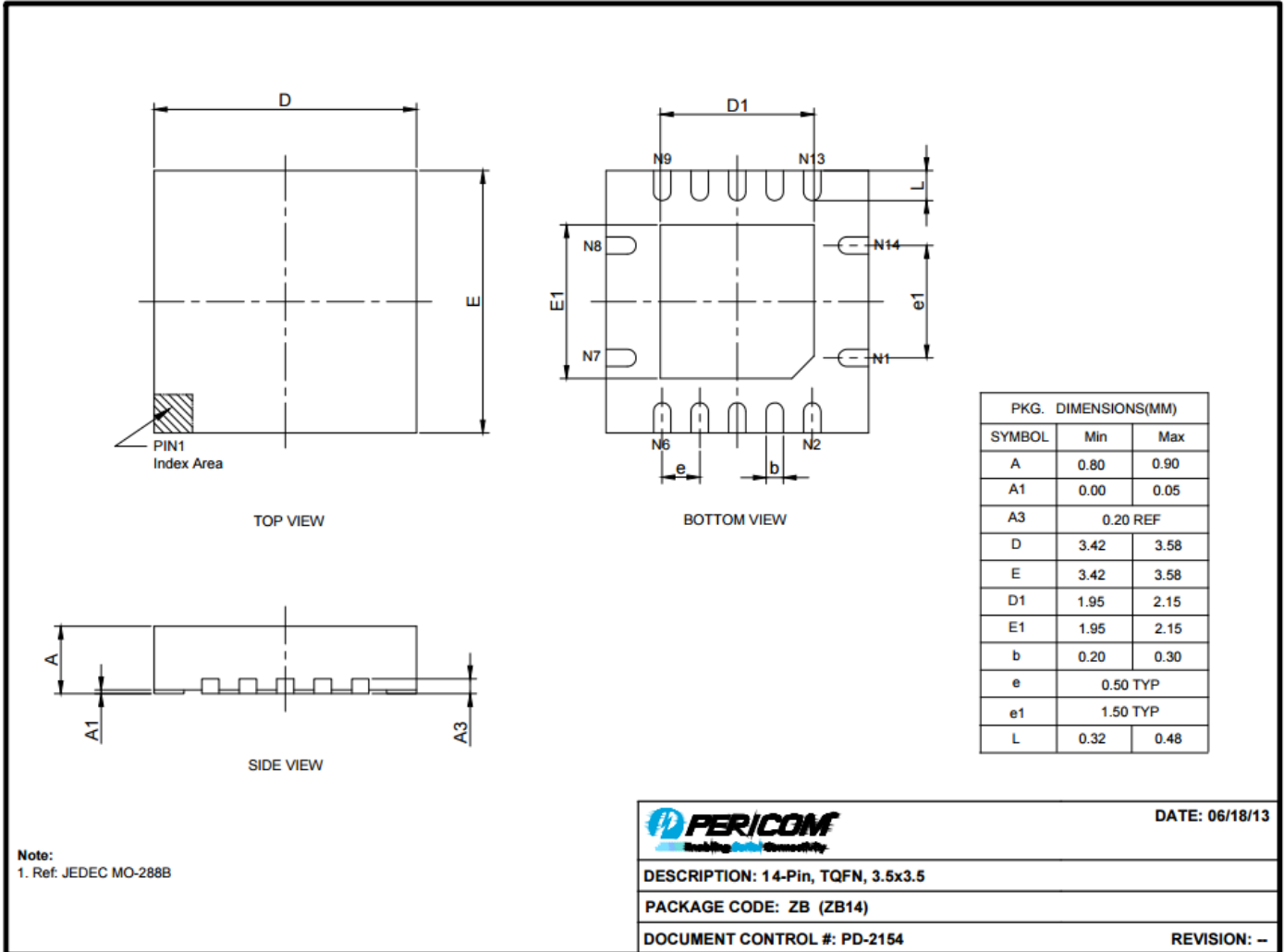
### Enable Input (EN)

The PI4ULS3V204 has an Enable pin (EN) that provides tri-state operation at the I/O pins. Driving the Enable pin to a low logic level minimizes the power consumption of the device and drives the I/O VCCB and I/O VCCA pins to a high impedance state. Normal translation operation occurs when the EN pin is equal to a logic high signal. The EN pin is referenced to the VCCA supply and has overvoltage tolerant protection.

### Power Supply Guidelines

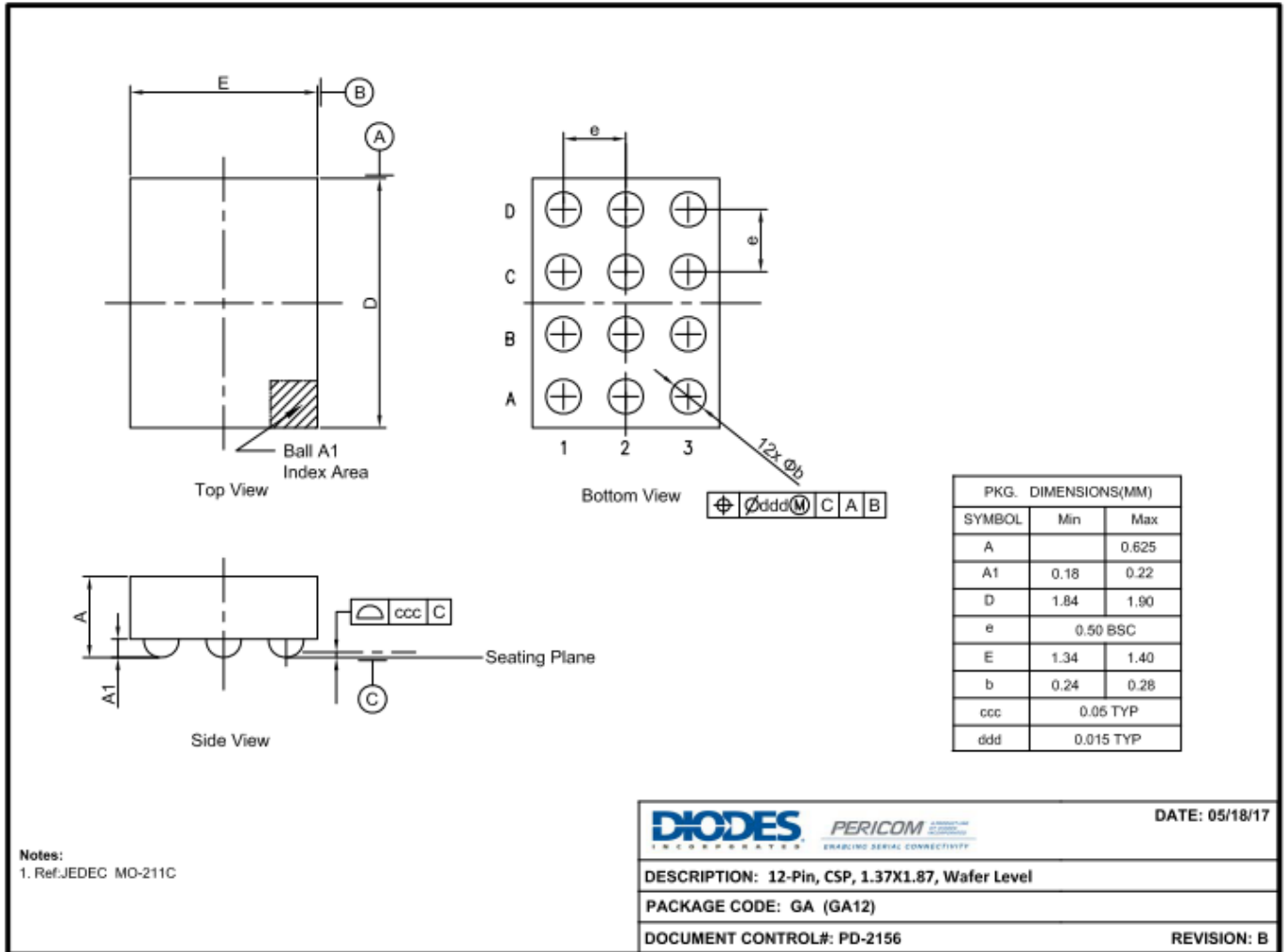
During normal operation, supply voltage VCCA can be greater than, less than or equal to VCCB. The sequencing of the power supplies will not damage the device during the power up operation. For optimal performance, 0.01μF to 0.1μF decoupling capacitors should be used on the VCCA and VCCB power supply pins. Ceramic capacitors are a good design choice to filter and bypass any noise signals on the voltage lines to the ground plane of the PCB. The noise immunity will be maximized by placing the capacitors as close as possible to the supply and ground pins, along with minimizing the PCB connection traces.

**Packaging Mechanical:**  
TQFN3.5x3.5-14L

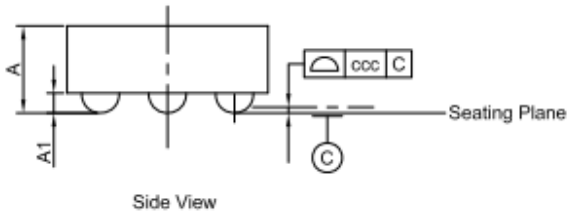
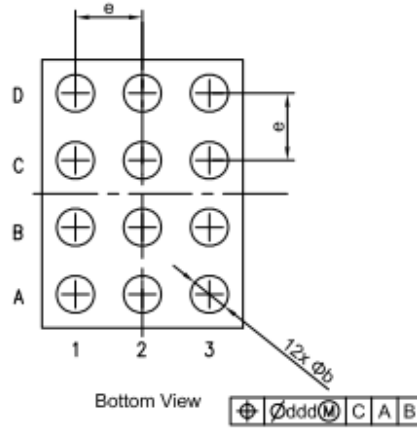
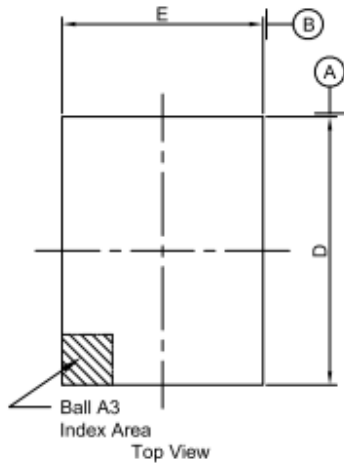


13-0193

**CSP1.37x1.87-12 (GA)**



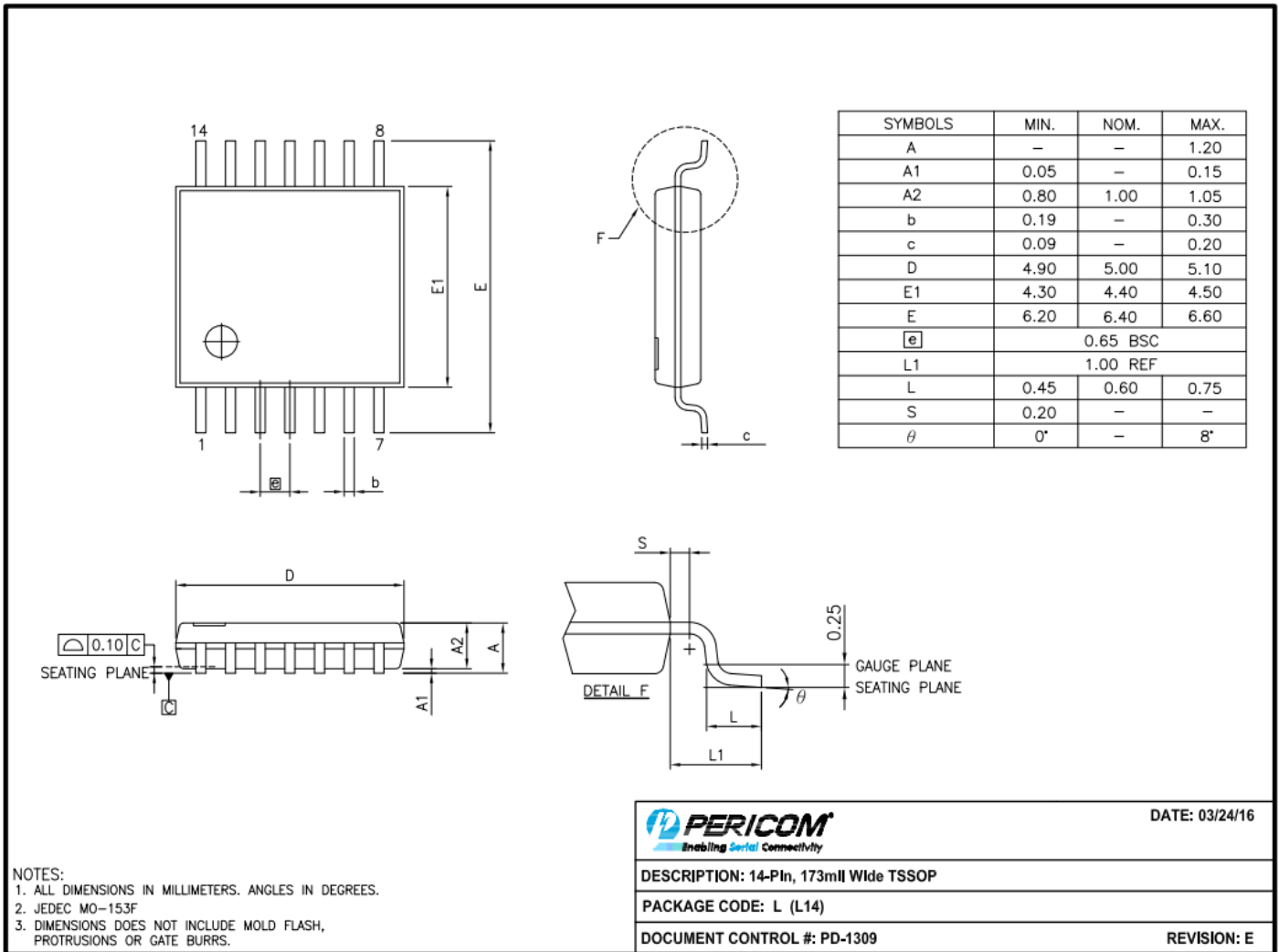
**CSP1.37x1.87-12 (GAA)**



PKG. DIMENSIONS(MM)		
SYMBOL	Min	Max
A		0.625
A1	0.18	0.22
D	1.84	1.90
e	0.50 BSC	
E	1.34	1.40
b	0.24	0.28
ccc	0.05 TYP	
ddd	0.015 TYP	

Notes:  
1. Ref. JEDEC MO-211C

**TSSOP-14(L)**



16-0060

For latest package info.

please check: <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>

**Ordering Information**

Part Number	Package Code	Package
PI4ULS3V204LEX	L	14-Pin, 173 mil Wide (TSSOP)
PI4ULS3V204ZBEX	ZB	14-pin, 3.5x3.5 (TQFN)
PI4ULS3V204GAEX	GA	12-pin, 1.37x1.87 (CSP) Wafer Level
PI4ULS3V204GAAEX	GAA	12-pin, 1.37x1.87 (CSP) Wafer Level

**Notes:**

- Thermal characteristics can be found on the company web site at [www.diodes.com/design/support/packaging/](http://www.diodes.com/design/support/packaging/)
- E = Pb-free and Green
- X suffix = Tape/Reel

**IMPORTANT NOTICE**

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

**LIFE SUPPORT**

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2016, Diodes Incorporated  
www.diodes.com



Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А