

## ***1-Bit Bidirectional Voltage-Level Translator with Auto Direction Sensing***

***UM3301B SOT563***

***UM3301DA DFN6 1.45×1.0***

### **General Description**

The UM3301B/UM3301DA series is one channel level translator with auto direction sensing. This 1-channel non-inverting translator uses two separate configurable power-supply rails. The A port is designed to track  $V_{CCA}$ .  $V_{CCA}$  accepts any supply voltage from 1.2V to 3.6V. The B port is designed to track  $V_{CCB}$ .  $V_{CCB}$  accepts any supply voltage from 1.65V to 5.5V. This allows for universal low-voltage bidirectional translation between any of the 1.2V, 1.5V, 1.8V, 2.5V, 3.3V, and 5V voltage nodes. Both I/O ports are auto-sensing, thus no direction control pin is required, making it ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems. The UM3301B/UM3301DA operates at a guaranteed data rate of 20Mbps over the entire specified operating voltage range. Within specific voltage domains, higher data rates are up to 100Mbps. When the output-enable (OE) input is low, all outputs are placed in the high-impedance state. The UM3301B/UM3301DA is designed so that the OE input circuit is designed to track  $V_{CCA}$ . To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pull down resistor, the minimum value of the resistor is determined by the current-sourcing capability of the driver. The UM3301DA is available in 1.45mm×1.0mm DFN6 package while the UM3301B is packaged in a SOT563 package.

### **Applications**

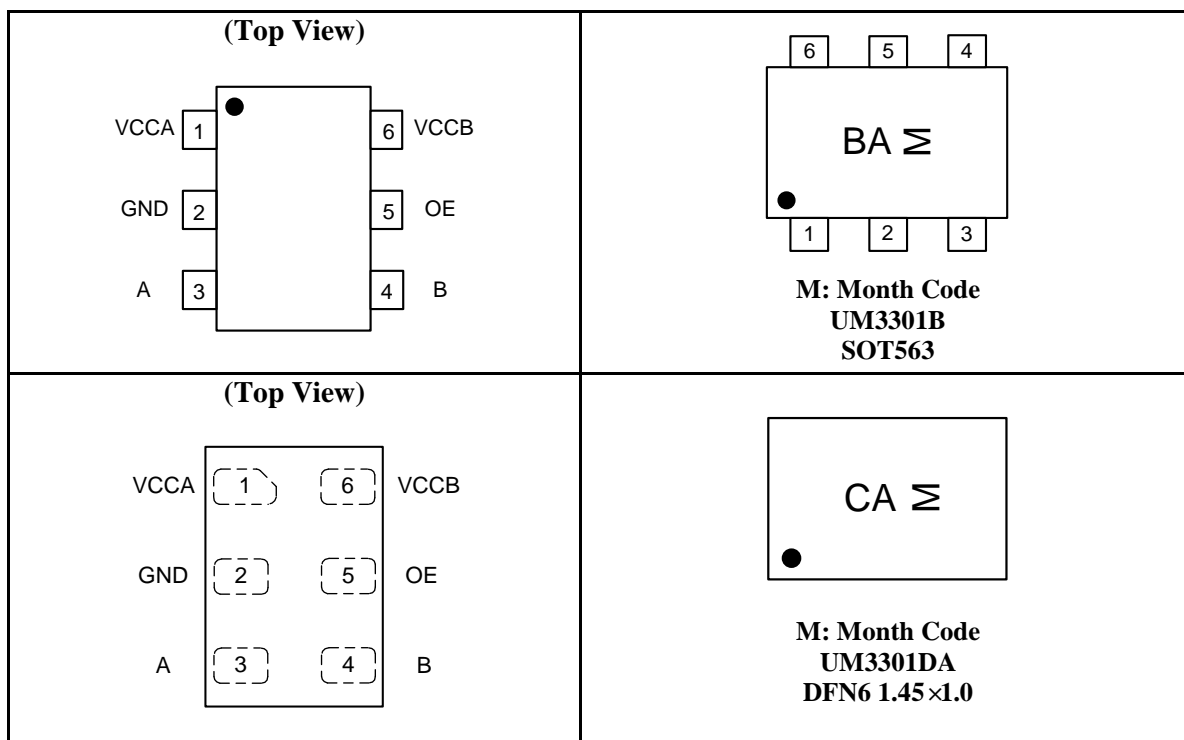
- Low-Voltage ASIC Level Translation
- Cell-Phone Cradles
- Portable POS Systems
- Portable Communication Devices
- Low-Cost Serial Interfaces
- Cell-Phones
- GPS
- Telecommunications Equipment

### **Features**

- 1.2V to 3.6V on A Port and 1.65V to 5.5V on B Port ( $V_{CCA} \leq V_{CCB}$ )
- $V_{CC}$  Isolation Feature—If Either  $V_{CC}$  Input is at GND, All Outputs are in the High-Impedance State
- OE Input Circuit Referenced to  $V_{CCA}$
- Low Power Consumption
- Latch-up Performance Exceeds 100mA
- $\pm 5$ kV ESD Protection on B Ports

## Pin Configurations

## Top View



## Pin Description

Pin	Name	Function
1	V <sub>CCA</sub>	A-Port supply voltage. $1.2V \leq V_{CCA} \leq 3.6V$ and $V_{CCA} \leq V_{CCB}$
2	GND	Ground
3	A	Input/Output A. Referenced to V <sub>CCA</sub>
4	B	Input/Output B. Referenced to V <sub>CCB</sub>
5	OE	3-state output enable. Pull OE low to place all outputs in 3-state mode. Referenced to V <sub>CCA</sub>
6	V <sub>CCB</sub>	B-Port supply voltage. $1.65V \leq V_{CCB} \leq 5.5V$

## Ordering Information

Part Number	Packaging Type	Marking Code	Shipping Qty
UM3301B	SOT563	BA	3000pcs/7Inch Tape & Reel
UM3301DA	DFN6 1.45x1.0	CA	3000pcs/7Inch Tape & Reel

**Absolute Maximum Ratings (Note 1)**

Over operating free-air temperature range (unless otherwise noted)

Symbol	Parameter		Value	Unit
$V_{CCA}$	Supply Voltage Range		-0.5 to +4.5	V
$V_{CCB}$	Supply Voltage Range		-0.5 to +6.5	V
$V_I$	Input Voltage Range	A ports	-0.5 to +4.5	V
		B ports	-0.5 to +6.5	
$V_O$	Voltage Range applied to any output in the high-impedance or power-off state	A ports	-0.5 to +4.5	V
		B ports	-0.5 to +6.5	
$V_O$	Voltage Range applied to any output in the high or low state (Note 2)	A ports	-0.5 to ( $V_{CCA}+0.5$ )	V
		B ports	-0.5 to ( $V_{CCB}+0.5$ )	
$I_{IK}$	Input Clamp Current	$V_I < 0$	-50	mA
$I_{OK}$	Output Clamp Current	$V_O < 0$	-50	mA
$I_O$	Continuous Output Current		$\pm 50$	mA
	Continuous Current through $V_{CCA}$ , $V_{CCB}$ , or GND		$\pm 100$	
$T_{OP}$	Operating Temperature Range		-40 to +85	$^{\circ}\text{C}$
$T_{STG}$	Storage Temperature Range		-65 to +150	$^{\circ}\text{C}$

Note1. Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note2. The value of  $V_{CCA}$  and  $V_{CCB}$  are provided in the recommended operating conditions table.

**Recommended Operating Conditions (Note 3, 4)**

Symbol	Parameter		$V_{CCA}$	$V_{CCB}$	Min	Max	Unit
$V_{CCA}$	Supply Voltage				1.2	3.6	V
$V_{CCB}$					1.65	5.5	V
$V_{IH}$	High Level Input Voltage	Data Inputs	1.2V to 3.6V	1.65V to 5.5V	$V_{CCI} \times 0.65^{(Note5)}$	$V_{CCI}$	V
		OE	1.2V to 3.6V	1.65V to 5.5V	$V_{CCA} \times 0.65$	5.5	V
$V_{IL}$	Low Level Input Voltage	Data Inputs	1.2V to 3.6V	1.65V to 5.5V	0	$V_{CCI} \times 0.35^{(Note5)}$	V
		OE	1.2V to 3.6V	1.65V to 5.5V	0	$V_{CCA} \times 0.35$	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state	A-Port	1.2V to 3.6V	1.65V to 5.5V	0	3.6	V
		B-Port			0	5.5	
$\Delta t/\Delta V$	Input Transition Rise or Fall Time	A-Port Inputs	1.2V to 3.6V	1.65V to 5.5V		40	ns/V
		B-Port Inputs		1.65V to 3.6V		40	
				4.5V to 5.5V		30	

Note3. The A and B sides of an unused data I/O pair must be held in the same state, i.e., both at  $V_{CCI}$  or both at GND.

Note4.  $V_{CCA}$  must be less than or equal to  $V_{CCB}$  and must not exceed 3.6 V.

Note5.  $V_{CCI}$  is the supply voltage associated with the input port.

**Electrical Characteristics (Note 6, 7)**

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

Parameter	Test Conditions	V <sub>CCA</sub>	V <sub>CCB</sub>	T <sub>A</sub> =25°C		-40°C to 85°C		Unit
				Min	Max	Min	Max	
V <sub>OHA</sub>	I <sub>OH</sub> =-20μA	1.2V		1.1		V <sub>CCA</sub> -0.4		V
		1.4V to 3.6V						
V <sub>OLA</sub>	I <sub>OL</sub> =20μA	1.2V				0.4		V
		1.4V to 3.6V				0.4		
V <sub>OHB</sub>	I <sub>OH</sub> =-20μA		1.65V to 5.5V			V <sub>CCB</sub> -0.4		V
V <sub>OLB</sub>	I <sub>OL</sub> =20μA		1.65V to 5.5V			0.4		V
I <sub>I</sub>	OE	V <sub>I</sub> =V <sub>CC1</sub> or GND	1.2V to 3.6V	1.65V to 5.5V	±1		±2	μA
I <sub>off</sub>	A Port	V <sub>I</sub> or V <sub>O</sub> =0 to 3.6V	0V	0V to 5.5V	±1		±2	μA
	B Port	V <sub>I</sub> or V <sub>O</sub> =0 to 5.5V	0V to 3.6V	0V	±1		±2	
I <sub>OZ</sub>	A or B Port	OE=GND	1.2V to 3.6V	1.65V to 5.5V	±1		±2	μA
I <sub>CCA</sub>	V <sub>I</sub> =V <sub>CC1</sub> or GND I <sub>O</sub> =0	1.2V	1.65V to 5.5V	0.06				μA
		1.4V to 3.6V	1.65V to 5.5V			5		
		3.6V	0V			2		
		0V	5.5V			-2		
I <sub>CCB</sub>	V <sub>I</sub> =V <sub>CC1</sub> or GND I <sub>O</sub> =0	1.2V	1.65V to 5.5V	3.4				μA
		1.4V to 3.6V	1.65V to 5.5V			5		
		3.6V	0V			-2		
		0V	5.5V			2		
I <sub>CCA</sub> + I <sub>CCB</sub>	V <sub>I</sub> =V <sub>CC1</sub> or GND I <sub>O</sub> =0	1.2V	1.65V to 5.5V	3.5				μA
		1.4V to 3.6V	1.65V to 5.5V			10		
I <sub>CCZA</sub>	V <sub>I</sub> =V <sub>CC1</sub> or GND I <sub>O</sub> =0, OE=GND	1.2V	1.65V to 5.5V	0.05				μA
		1.4V to 3.6V	1.65V to 5.5V			5		
I <sub>CCZB</sub>	V <sub>I</sub> =V <sub>CC1</sub> or GND I <sub>O</sub> =0, OE=GND	1.2V	1.65V to 5.5V	3.3				μA
		1.4V to 3.6V	1.65V to 5.5V			5		
C <sub>i</sub>	OE		1.2V to 3.6V	1.65V to 5.5V	4.5			pF
C <sub>iO</sub>	A Port		1.2V to 3.6V	1.65V to 5.5V	12			pF
	B Port				15			

 Note6. V<sub>CC1</sub> is the supply voltage associated with the input port.

 Note7. V<sub>CCO</sub> is the supply voltage associated with the output port.

**Switching Characteristics**
 $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{CCA} = 1.2\text{V}$ 

Parameter	From (Input)	To (Output)	$V_{CCB}=1.8\text{V}$	$V_{CCB}=2.5\text{V}$	$V_{CCB}=3.3\text{V}$	$V_{CCB}=5\text{V}$	Unit
			Typ	Typ	Typ	Typ	
$t_{pd}$	A	B	11	9.6	9.4	11.2	ns
	B	A	12	10.8	10	10	
$t_{en}$	OE	A	0.5	0.5	0.5	0.5	$\mu\text{s}$
		B	0.5	0.5	0.5	0.5	
$t_{dis}$	OE	A	114	118	118	114	ns
		B	480	450	265	160	
$t_{rA}, t_{fA}$	A port rise and fall time		5	5	5	5	ns
$t_{rB}, t_{fB}$	B port rise and fall time		3.2	2.9	2.8	3.2	ns
$t_{SK(O)}$	Channel-to-channel		0.5	0.5	0.5	1.5	ns
Max data rate			20	20	20	20	Mbps

**Switching Characteristics**

 Over recommended operating free-air temperature range,  $V_{CCA} = 1.5\text{V} \pm 0.1\text{V}$  (unless otherwise noted)

Parameter	From (Input)	To (Output)	$V_{CCB}=1.8\text{V} \pm 0.15\text{V}$		$V_{CCB}=2.5\text{V} \pm 0.2\text{V}$		$V_{CCB}=3.3\text{V} \pm 0.3\text{V}$		$V_{CCB}=5\text{V} \pm 0.5\text{V}$		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
$t_{pd}$	A	B	2	15	1.2	11	1.1	10	1	10	ns
	B	A	1	15	0.9	12	0.5	12	0.3	13	
$t_{en}$	OE	A		1		1		1		1	$\mu\text{s}$
		B		1		1		1		1	
$t_{dis}$	OE	A		180		140		100		100	ns
		B		550		550		530		110	
$t_{rA}, t_{fA}$	A port rise and fall time		1.5	5.0	1.5	5.0	1.5	5.0	1.5	5.0	ns
$t_{rB}, t_{fB}$	B port rise and fall time		0.9	4.5	0.6	3.5	0.5	3.0	0.4	4.0	ns
$t_{SK(O)}$	Channel-to-channel			0.5		0.5		0.5		0.5	ns
Max data rate				40		40		40		40	Mbps

**Switching Characteristics**

Over recommended operating free-air temperature range,  $V_{CCA}=1.8V \pm 0.15V$  (unless otherwise noted)

Parameter	From (Input)	To (Output)	$V_{CCB}=1.8V \pm 0.15V$		$V_{CCB}=2.5V \pm 0.2V$		$V_{CCB}=3.3V \pm 0.3V$		$V_{CCB}=5V \pm 0.5V$		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
$t_{pd}$	A	B	1.6	12	1.4	10	1.3	9	1.2	9	ns
	B	A	1.5	12	1.3	8.5	1	8	0.9	8	
$t_{en}$	OE	A	1		1		1		1		$\mu s$
		B	1		1		1		1		
$t_{dis}$	OE	A	130		130		130		100		ns
		B	200		550		450		200		
$t_{rA}, t_{fA}$	A port rise and fall time		1	4.2	1.1	4.0	1.1	4.0	1.1	4.0	ns
$t_{rB}, t_{fB}$	B port rise and fall time		0.9	4	0.6	4	0.5	4	0.4	4	ns
$t_{SK(O)}$	Channel-to-channel		0.5		0.5		0.5		0.5		ns
Max data rate			60		60		60		60		Mbps

**Switching Characteristics**

Over recommended operating free-air temperature range,  $V_{CCA}=2.5V \pm 0.2V$  (unless otherwise noted)

Parameter	From (Input)	To (Output)	$V_{CCB}=2.5V \pm 0.2V$		$V_{CCB}=3.3V \pm 0.3V$		$V_{CCB}=5V \pm 0.5V$		Unit
			Min	Max	Min	Max	Min	Max	
$t_{pd}$	A	B	1.1	8.9	1	7.8	0.9	7.2	ns
	B	A	1.2	8.9	1.1	8	0.9	7.6	
$t_{en}$	OE	A	1		1		1		$\mu s$
		B	1		1		1		
$t_{dis}$	OE	A	150		150		150		ns
		B	200		300		250		
$t_{rA}, t_{fA}$	A port rise and fall time		0.8	3	0.8	3	0.8	3	ns
$t_{rB}, t_{fB}$	B port rise and fall time		0.7	3	0.5	3	0.4	3	ns
$t_{SK(O)}$	Channel-to-channel		0.5		0.5		0.5		ns
Max data rate			100		100		100		Mbps

**Switching Characteristics**

Over recommended operating free-air temperature range,  $V_{CCA}=3.3V\pm 0.3V$  (unless otherwise noted)

Parameter	From (Input)	To (Output)	$V_{CCB}=3.3V\pm 0.3V$		$V_{CCB}=5V\pm 0.5V$		Unit
			Min	Max	Min	Max	
$t_{pd}$	A	B	0.9	7	0.8	7	ns
	B	A	1	7	0.9	7	
$t_{en}$	OE	A		1		1	$\mu s$
		B		1		1	
$t_{dis}$	OE	A		150		120	ns
		B		150		200	
$t_{rA}, t_{fA}$	A port rise and fall time		0.7	3.5	0.7	3.5	ns
$t_{rB}, t_{fB}$	B port rise and fall time		0.5	3.0	0.4	3.0	ns
$t_{SK(O)}$	Channel-to-channel			0.5		0.5	ns
Max data rate			100		100		Mbps

## Applications Information

The UM3301B/UM3301DA ESD protected level translator provides level shifting necessary to allow data transfer in a multi-voltage system. Externally applied voltages,  $V_{CCA}$  and  $V_{CCB}$  set the logic levels on either side of device. A low voltage signal present on  $V_{CCA}$  side of the device appears as a high voltage logic signal on the  $V_{CCB}$  side of the device, and vice-versa.

## Block Diagram

The UM3301B/UM3301DA (block diagram see Figure 1) does not require a direction-control signal to control the direction of data flow from A to B or from B to A. In a dc state, the output drivers of the UM3301B/UM3301DA can maintain a high or low, but are designed to be weak, so that they can be overdriven by an external driver when data on the bus starts flowing towards the opposite direction.

The output one shot detects rising or falling edges on the A or B ports. During a rising edge, the one shot turns on the PMOS transistors (T1, T3) for a short duration, which speeds up the low-to-high transition. Similarly, during a falling edge, the one shot turns on the NMOS transistors (T2, T4) for a short duration, which speeds up the high-to-low transition.

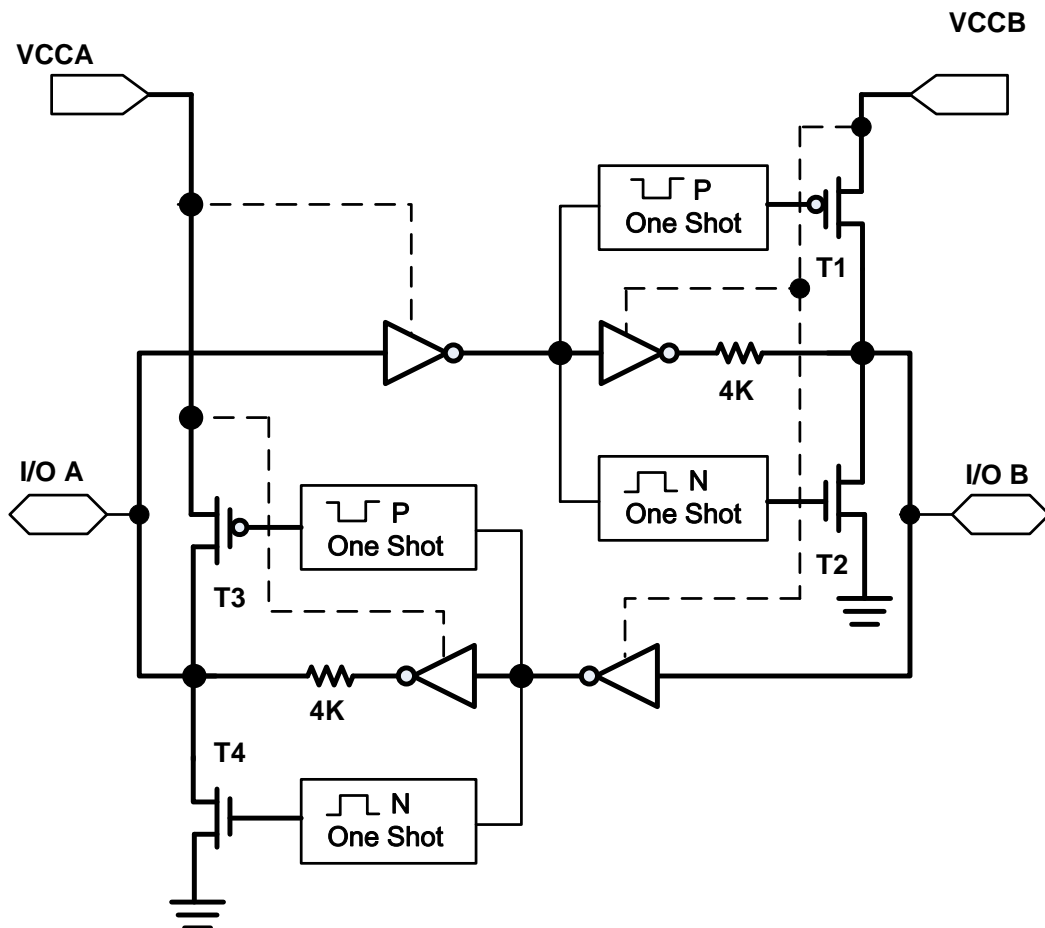
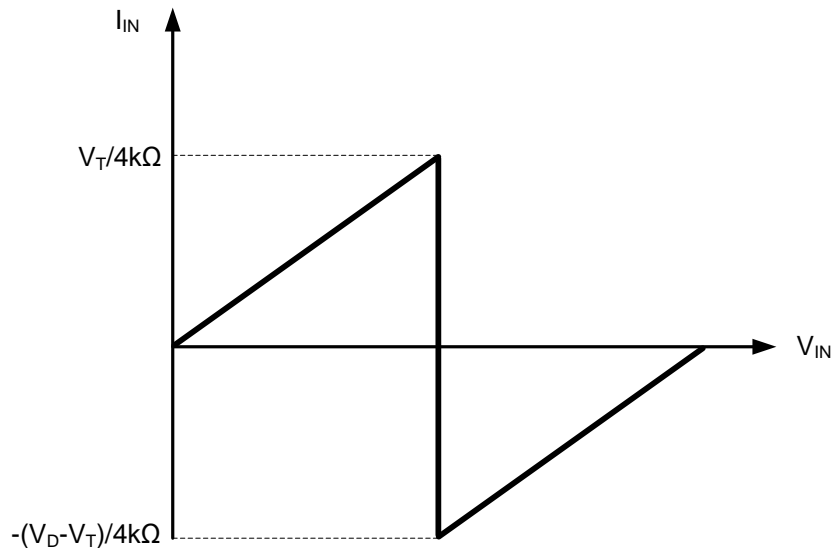


Figure 1 Block Diagram of UM3301B/UM3301DA I/O Cell



## Input Driver Requirements

Typical  $I_{IN}$  vs  $V_{IN}$  characteristics of the UM3301B/UM3301DA are shown in Figure 2. For proper operation, the device driving the data I/Os of the UM3301B/UM3301DA must have drive strength of at least  $\pm 2$  mA.



- A:  $V_T$  is the input threshold voltage of the UM3301B/UM3301DA (typical  $V_{CC1}/2$ )  
 B:  $V_D$  is the supply voltage of the external driver.

**Figure 2 Typical  $I_{IN}$  vs  $V_{IN}$  Curve**

## Power Up

During operation, ensure that  $V_{CCA} \leq V_{CCB}$  at all times. During power-up sequencing,  $V_{CCA} \geq V_{CCB}$  does not damage the device, so any power supply can be ramped up first. The UM3301B/UM3301DA has circuitry that disables all output ports when either  $V_{CC}$  is switched off ( $V_{CCA/B} = 0$  V).

## Enable and Disable

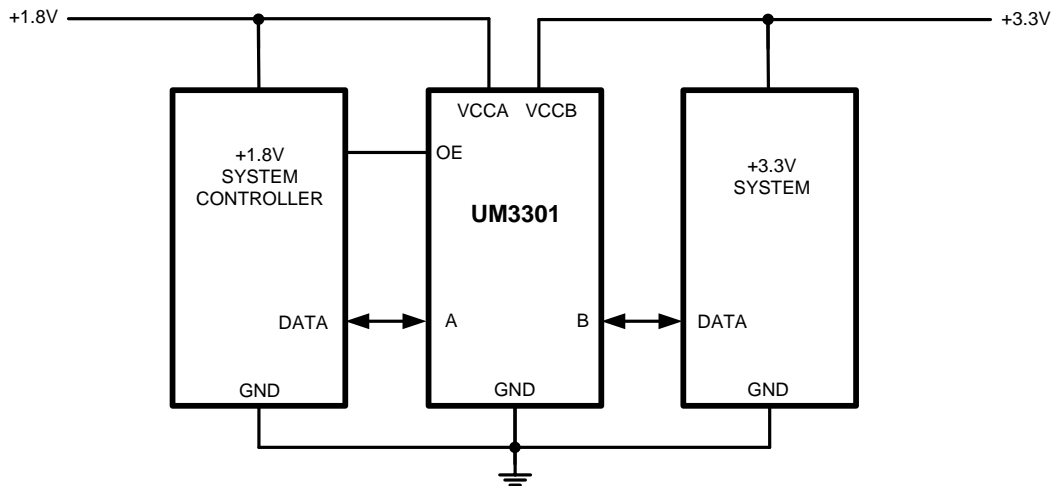
The UM3301B/UM3301DA has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time ( $t_{dis}$ ) indicates the delay between when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time ( $t_{en}$ ) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

## Pullup or Pulldown Resistors on I/O Lines

The UM3301B/UM3301DA is designed to drive capacitive loads of up to 70pF. The output drivers of the UM3301B/UM3301DA have low dc drive strength. External pullup or pulldown resistors need to be higher than 50kΩ.

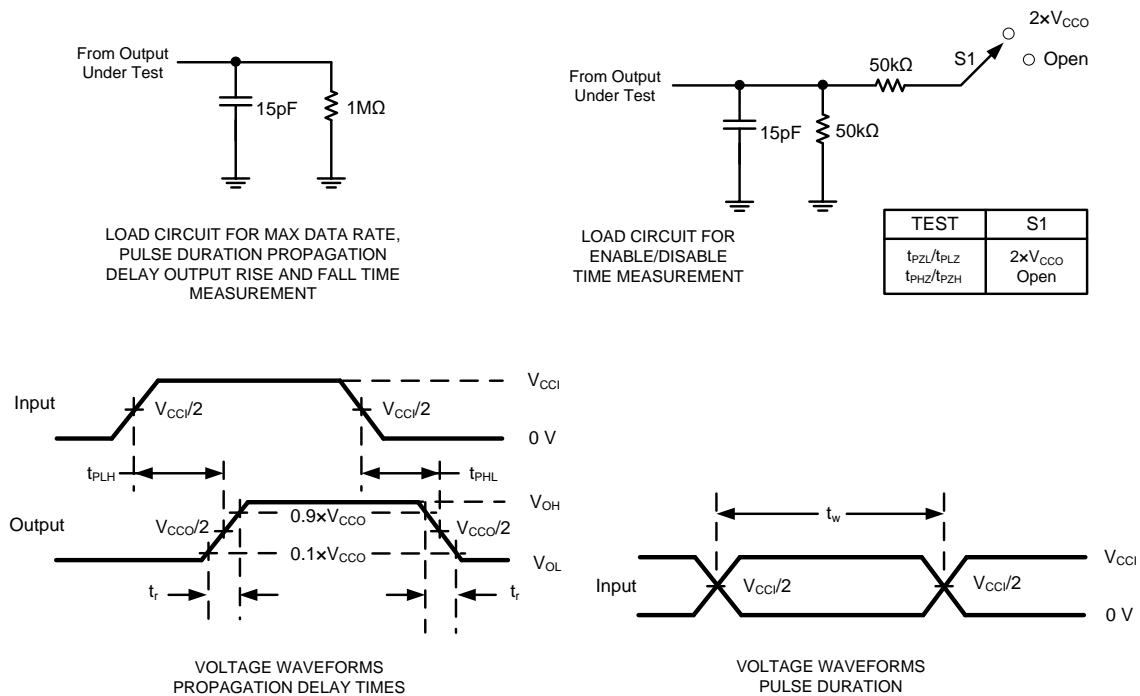
For the same reason, the UM3301B/UM3301DA should not be used in open-drain system, such as I<sup>2</sup>C or 1-wire system.

## Typical Operating Circuit



**Figure 3** Typical operating circuit

## Test Circuits



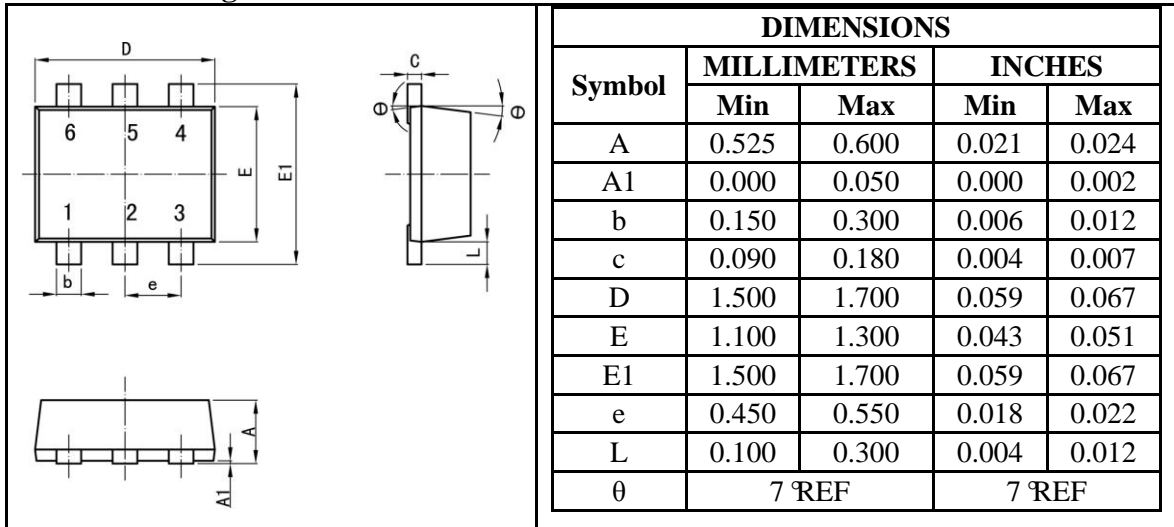
- A.  $C_L$  includes probe and jig capacitance.
- B. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\text{MHz}$ ,  $Z_0 = 50\Omega$ ,  $dv/dt \geq 1\text{V/ns}$ .
- C. The outputs are measured one at a time, with one transition per measurement.
- D.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
- E.  $V_{CCi}$  is the  $V_{CC}$  associated with the input port.
- F.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- G. All parameters and waveforms are not applicable to all devices.

**Figure 4** Load Circuits and Voltage Waveforms

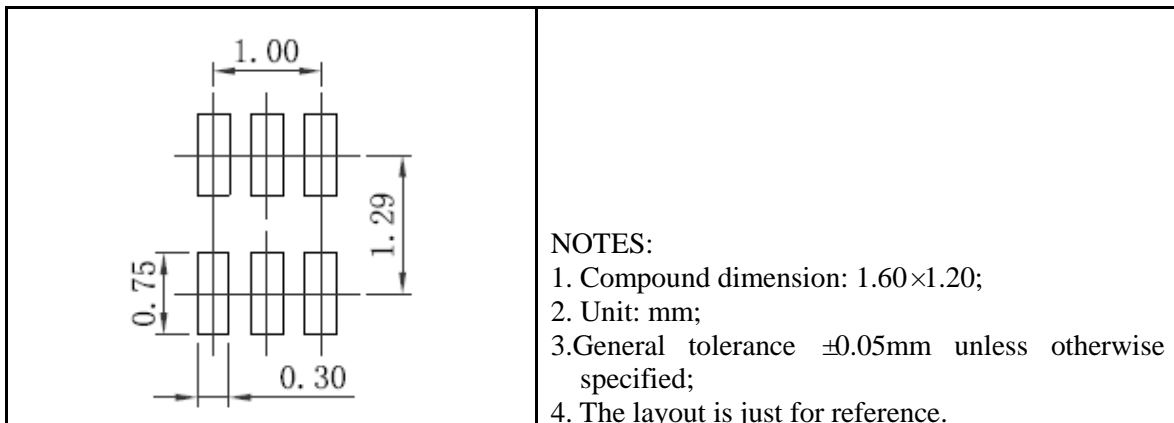
## Package Information

### UM3301B SOT563

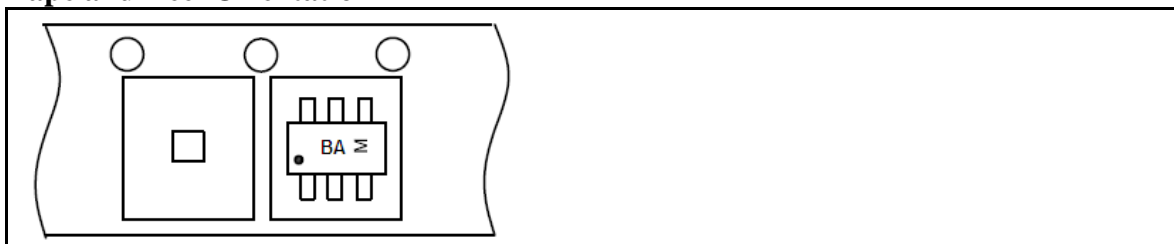
#### Outline Drawing



#### Land Pattern

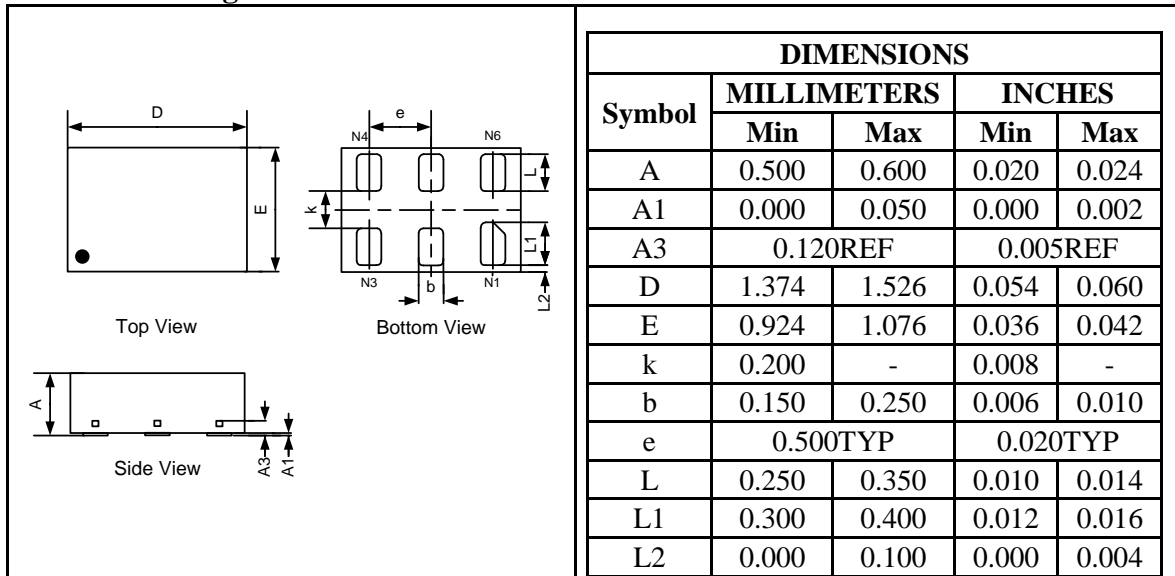


#### Tape and Reel Orientation

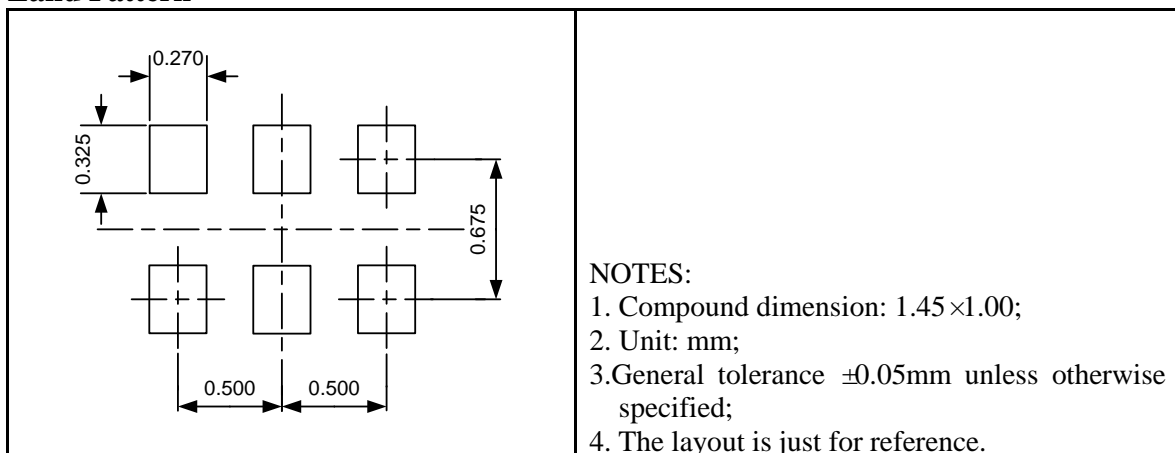


## UM3301DA DFN6 1.45×1.0

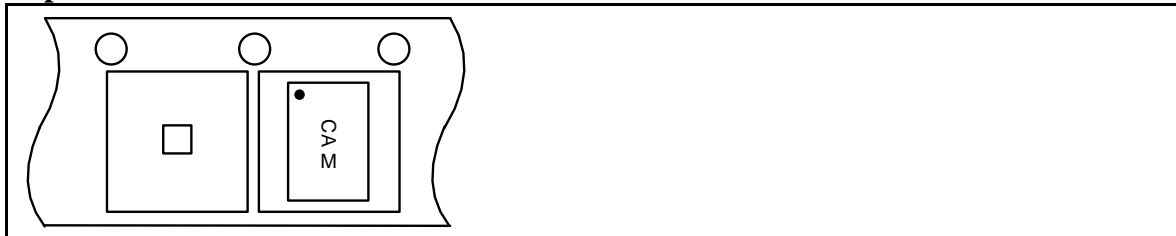
### Outline Drawing



### Land Pattern



### Tape and Reel Orientation



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Union Semiconductor, Inc

Add: Unit 606, No.570 Shengxia Road, Shanghai 201210

Tel: 021-51093966

Fax: 021-51026018

Website: [www.union-ic.com](http://www.union-ic.com)