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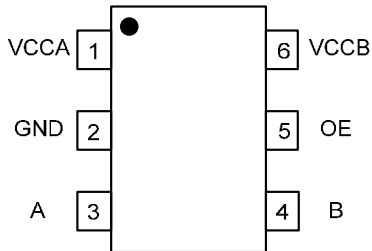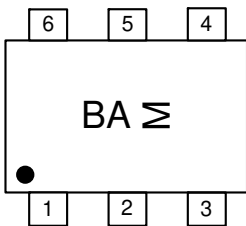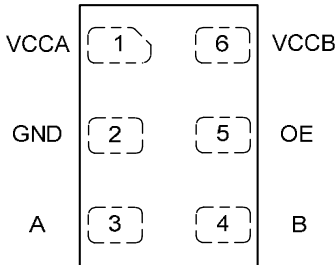
Applications
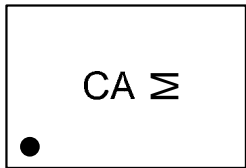
- Low-Voltage ASIC Level Translation
- Cell-Phone Cradles
- Portable POS Systems
- Portable Communication Devices
- Low-Cost Serial Interfaces
- Cell-Phones
- GPS
- Telecommunications Equipment

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
- ±5kV ESD Protection on B Ports

Pin Configurations   Top View

(Top View)

M: Month Code
UM3301B
SOT563

M: Month Code
UM3301DA
DFN6 1.45×1.0

Pin Description

Pin	Name	Function
1	V_{CCA}	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_{CCA}.
4	B	Input/Output B. Referenced to V_{CCB}.
5	OE	3-State Output Enable. Pull OE low to place all outputs in 3-state mode. Referenced to V_{CCA}.
6	V_{CCB}	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 1.45×1.0	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		±50	mA
	Continuous Current through V_{CCA}, V_{CCB}, or GND		±100	mA
T_{OP}	Operating Temperature Range		-40 to +85	°C
T_{STG}	Storage Temperature Range		-65 to +150	°C

Note 1. 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.

Note 2. 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	$V_{CCI}×0.65$ [Note5]	V_{CCI}	V
		OE	1.2V to 3.6V	1.65V to 5.5V	$V_{CCA}×0.65$	5.5	V
V_{IL}	Low Level Input Voltage	Data Inputs	1.2V to 3.6V	1.65V to 5.5V	0	$V_{CCI}×0.35$ [Note5]	V
		OE	1.2V to 3.6V	1.65V to 5.5V	0	$V_{CCA}×0.35$	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	1.2V to 3.6V	1.65V to 3.6V		40	
				4.5V to 5.5V		30	

Note 3. 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.

Note 4. V_{CCA} must be less than or equal to V_{CCB} and must not exceed 3.6 V.

Note 5. 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_{CCA}	V_{CCB}	$T_A=25°C$ Min	Max	-40°C to 85°C Min	Max	Unit
V_{OHA}		$I_{OH}=-20\mu A$	1.2V		1.1				V
			1.4V to 3.6V				$V_{CCA}-0.4$		
V_{OLA}		$I_{OL}=20\mu A$	1.2V					0.4	V
			1.4V to 3.6V					0.4	
V_{OHB}		$I_{OH}=-20\mu A$		1.65V to 5.5V			$V_{CCB}-0.4$		V
V_{OLB}		$I_{OL}=20\mu A$		1.65V to 5.5V				0.4	V
I_I	OE	$V_I=V_{CCI}$ or GND	1.2V to 3.6V	1.65V to 5.5V		±1		±2	μA
I_{off}	A Port	V_I or V_O=0 to 3.6V	0V	0V to 5.5V		±1		±2	μA
	B Port	V_I or V_O=0 to 5.5V	0V to 3.6V	0V		±1		±2	
I_{OZ}	A or B Port	OE=GND	1.2V to 3.6V	1.65V to 5.5V		±1		±2	μA
I_{CCA}		$V_I=V_{CCI}$ or GND $I_O=0$	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_{CCB}		$V_I=V_{CCI}$ or GND $I_O=0$	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	
$I_{CCA}+I_{CCB}$		$V_I=V_{CCI}$ or GND $I_O=0$	1.2V	1.65V to 5.5V	3.5				μA
			1.4V to 3.6V	1.65V to 5.5V				10	
I_{CCZA}		$V_I=V_{CCI}$ or GND $I_O=0$, OE=GND	1.2V	1.65V to 5.5V	0.05				μA
			1.4V to 3.6V	1.65V to 5.5V				5	
I_{CCZB}		$V_I=V_{CCI}$ or GND $I_O=0$, OE=GND	1.2V	1.65V to 5.5V	3.3				μA
			1.4V to 3.6V	1.65V to 5.5V				5	
C_i	OE		1.2V to 3.6V	1.65V to 5.5V	4.5				pF
C_{iO}	A Port		1.2V to 3.6V	1.65V to 5.5V	12				pF
	B Port				15				

Note 6. V_{CCI} is the supply voltage associated with the input port.
Note 7. V_{CCO} is the supply voltage associated with the output port.

Switching Characteristics

T_A=+25°C, V_{CCA}=1.2V

Parameter	From (Input)	To (Output)	V_{CCB}=1.8V Typ	V_{CCB}=2.5V Typ	V_{CCB}=3.3V Typ	V_{CCB}=5V Typ	Unit
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	μs
		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}=1.5V±0.1V (unless otherwise noted)

Parameter	From (Input)	To (Output)	V_{CCB}=1.8V ±0.15V Min	V_{CCB}=1.8V ±0.15V Max	V_{CCB}=2.5V ±0.2V Min	V_{CCB}=2.5V ±0.2V Max	V_{CCB}=3.3V ±0.3V Min	V_{CCB}=3.3V ±0.3V Max	V_{CCB}=5V ±0.5V Min	V_{CCB}=5V ±0.5V Max	Unit
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	μs
		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±0.15V (unless otherwise noted)

Parameter	From (Input)	To (Output)	V_{CCB}=1.8V ±0.15V Min	Max	V_{CCB}=2.5V ±0.2V Min	Max	V_{CCB}=3.3V ±0.3V Min	Max	V_{CCB}=5V ±0.5V Min	Max	Unit
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	μs
		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±0.2V (unless otherwise noted)

Parameter	From (Input)	To (Output)	V_{CCB}=2.5V ±0.2V Min	Max	V_{CCB}=3.3V ±0.3V Min	Max	V_{CCB}=5V ±0.5V Min	Max	Unit
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	μs
		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±0.3V (unless otherwise noted)

Parameter	From (Input)	To (Output)	V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±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	μs
		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.
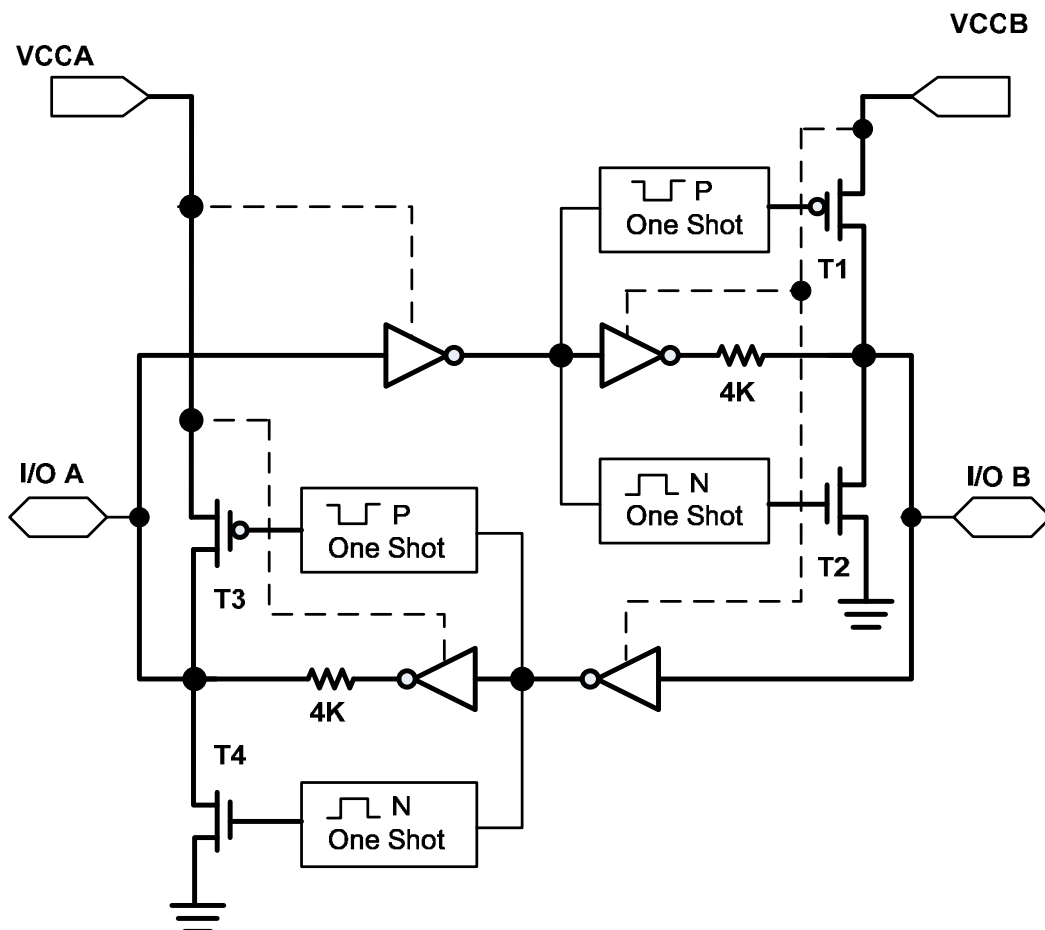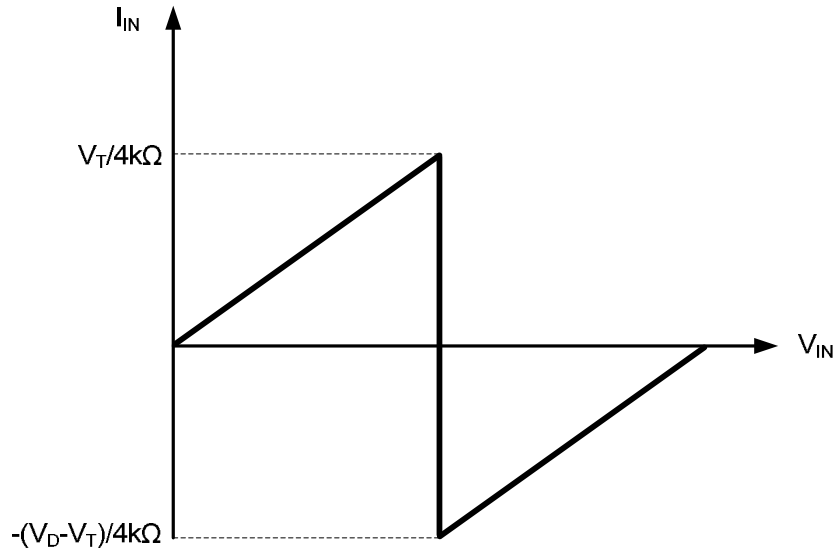
Figure 1 Block Diagram of UM3301B/UM3301DA I/O Cell

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 ±2mA.

A: V_T is the input threshold voltage of the
UM3301B/UM3301DA (typical $V_{CCI}/2$).
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 ($V_{CCA/B}=0V$).

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.

Pull-up or Pull-down 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 pull-up or pull-down resistors need to be higher than 50kΩ.
For the same reason, the UM3301B/UM3301DA should not be used in open-drain system, such as I²C or 1-wire system.
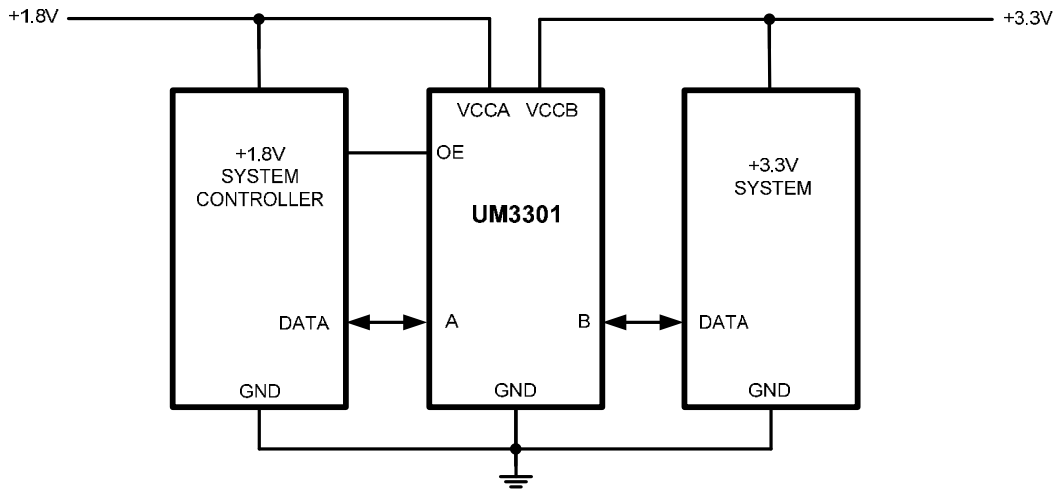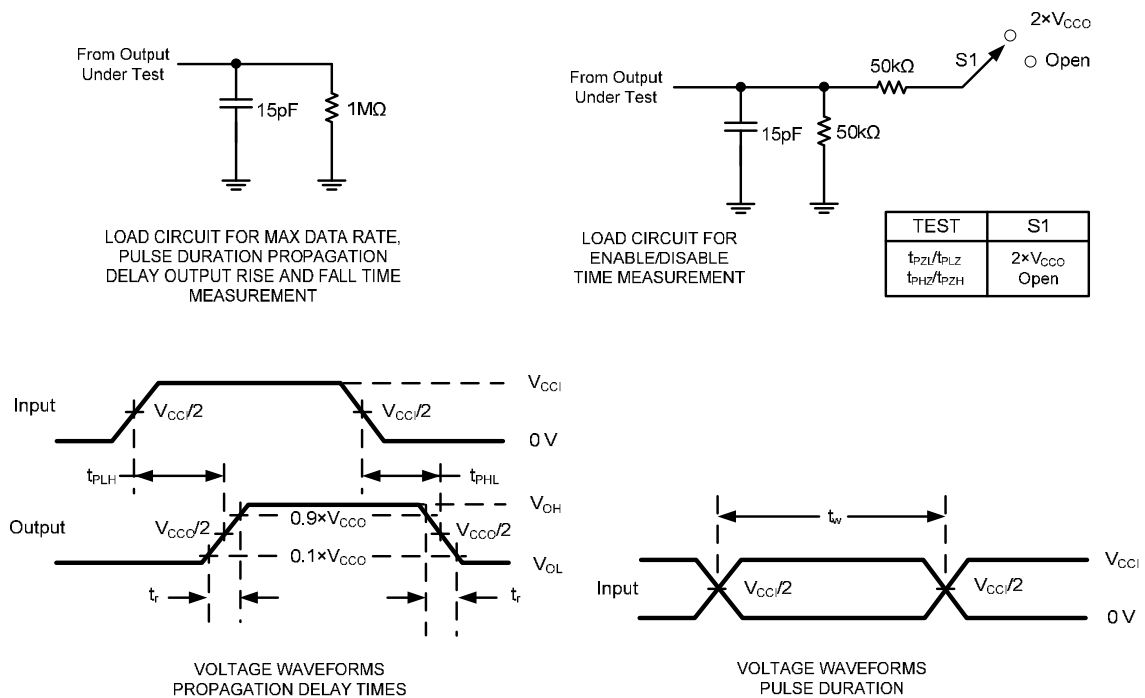
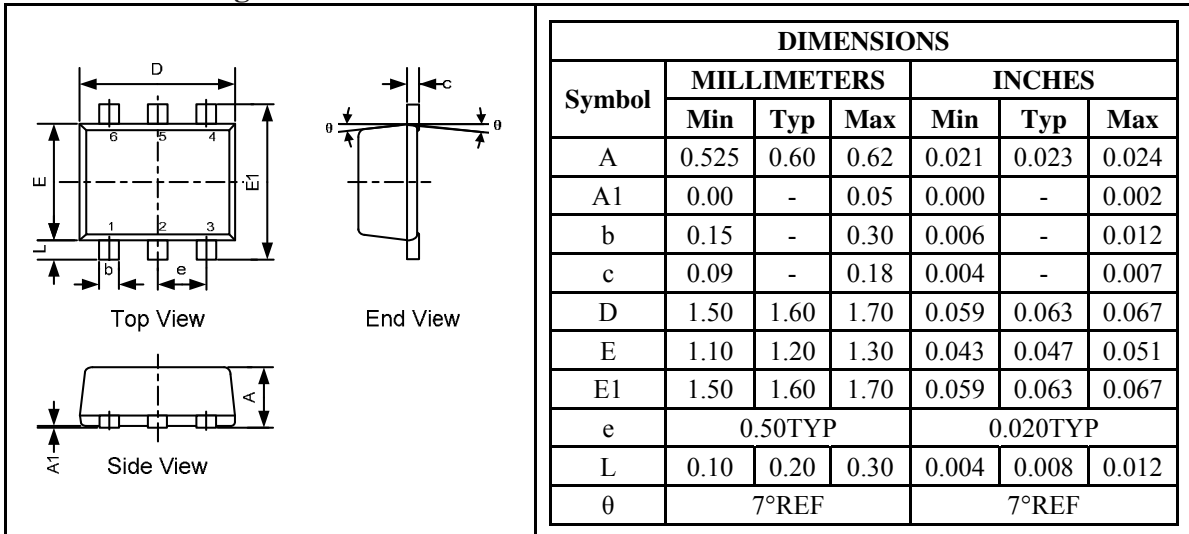## Typical Operating Circuit

Figure 3 Typical Operating Circuit

Test Circuits

LOAD CIRCUIT FOR MAX DATA RATE,
PULSE DURATION PROPAGATION
DELAY OUTPUT RISE AND FALL TIME
MEASUREMENT

LOAD CIRCUIT FOR
ENABLE/DISABLE
TIME MEASUREMENT

TEST	S1
t_{PZL}/t_{PLZ}	$2 \times V_{CCO}$
t_{PHZ}/t_{PZH}	Open

VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

VOLTAGE WAVEFORMS
PULSE DURATION

A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR≤10MHz, Z_O=50Ω,dv/dt≥1V/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.

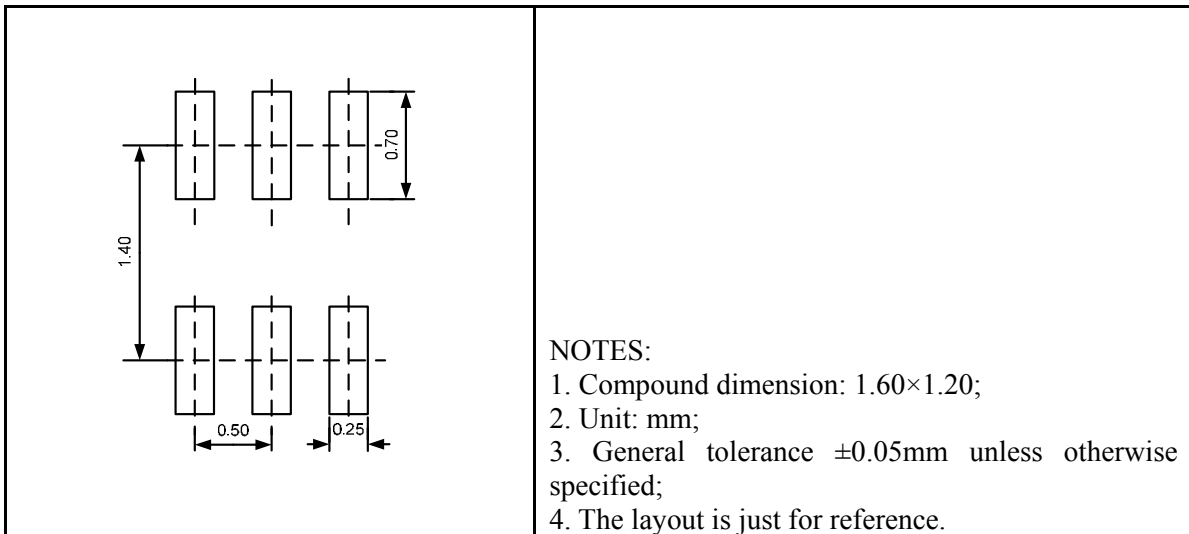**Figure 4 Load Circuits and Voltage Waveforms**
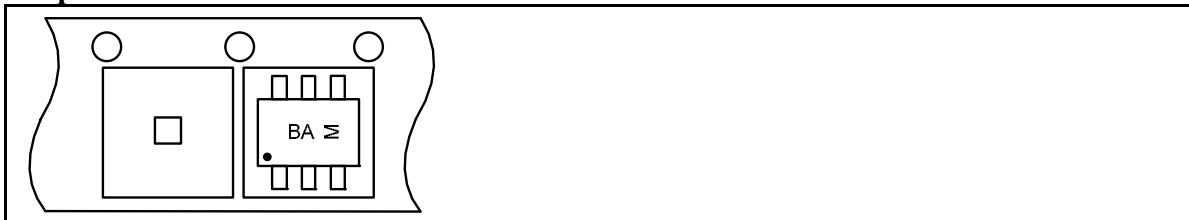
Package Information

UM3301B SOT563

Outline Drawing

Top View   End View   Side View

DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	0.525	0.60	0.62	0.021	0.023	0.024
A1	0.00	-	0.05	0.000	-	0.002
b	0.15	-	0.30	0.006	-	0.012
c	0.09	-	0.18	0.004	-	0.007
D	1.50	1.60	1.70	0.059	0.063	0.067
E	1.10	1.20	1.30	0.043	0.047	0.051
E1	1.50	1.60	1.70	0.059	0.063	0.067
e	0.50TYP			0.020TYP		
L	0.10	0.20	0.30	0.004	0.008	0.012
θ	7°REF			7°REF		

Land Pattern

NOTES:
1. Compound dimension: 1.60×1.20;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

Tape and Reel Orientation

UM3301DA DFN6 1.45×1.0

Outline Drawing

DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	-	-	0.60	-	-	0.024
A1	0.00	-	0.05	0.000	-	0.002
A3	0.12REF			0.005REF		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	1.35	-	1.526	0.053	-	0.060
E	0.924	-	1.076	0.036	-	0.042
e	0.50TYP			0.020TYP		
k	0.20	-	-	0.008	-	-
L1	0.25	-	0.40	0.010	-	0.016
L2	0.00	-	0.10	0.000	-	0.004

Land Pattern

NOTES:
1. Compound dimension: 1.45×1.00;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.
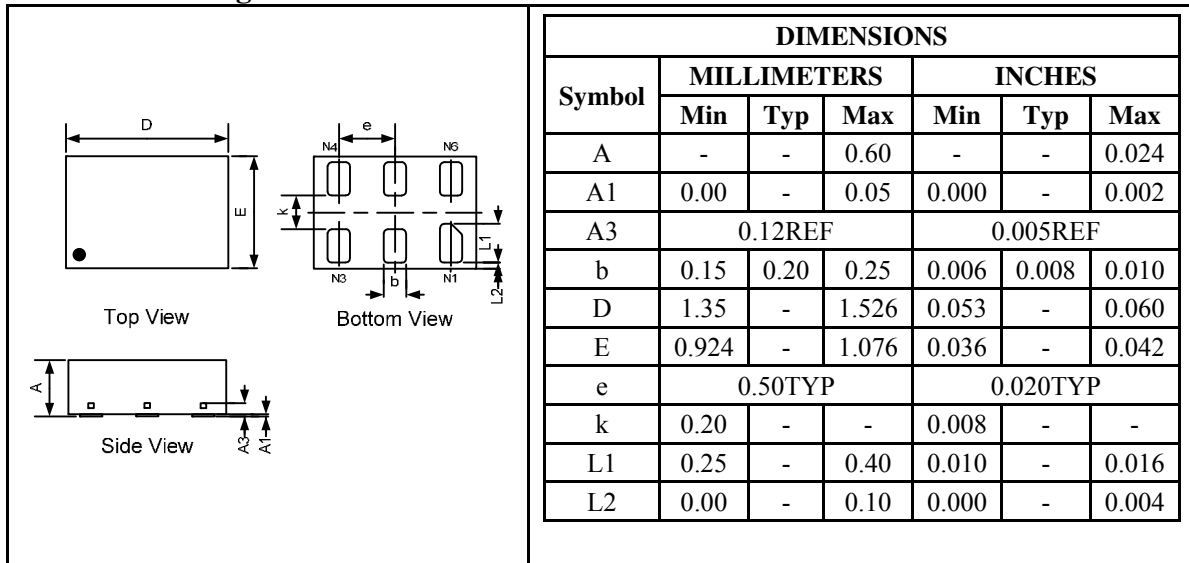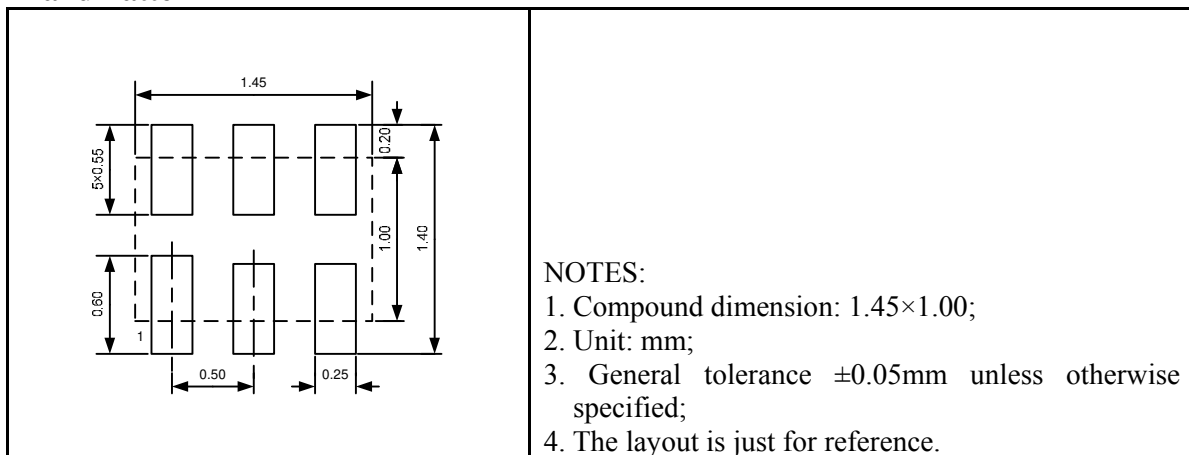
Tape and Reel Orientation

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GREEN COMPLIANCE

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