Single-Bit Dual-Supply Bus Transceiver With Configurable Voltage Translation and 3-State Outputs

UM3601S *SOT23-6*

General Description

The UM3601 is a dual-supply, single-bit non-inverting bus transceiver that is optimized to operate with V_{CCA} and V_{CCB} set at 1.65V to 5.5V. The A port is designed to track V_{CCA}. V_{CCA} accepts any supply voltage from 1.65V to 5.5V. The B port is designed to track V_{CCB}. V_{CCB} accepts any supply voltage from 1.65V to 5.5 V. This allows for universal low-voltage bidirectional translation between any of the 1.8V, 2.5V, 3.3V, and 5.5V voltage nodes.

The UM3601 is designed for asynchronous communication between two data buses. The logic levels of the direction-control (DIR) input activate either the B-port output or the A-port output. The device transmits data from the A bus to the B bus when the B-port outputs are activated, and from the B bus to the A bus when the A-port outputs are activated. The input circuitry on both A and B ports is always active and must have a logic HIGH or LOW level applied to prevent excess I_{CC} and I_{CCZ}.

In the design of the UM3601, the control pin (DIR) is supplied by V_{CCA}.

The UM3601S is available in SOT23-6 package.

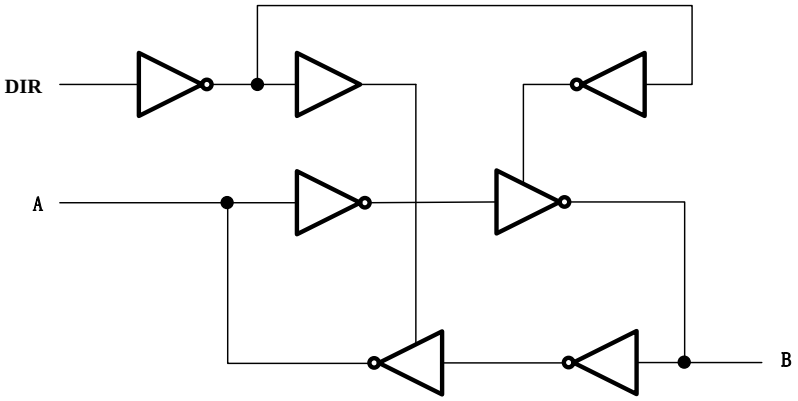
Applications

- Personal Electronic
- Industrial
- Enterprise
- Telecom

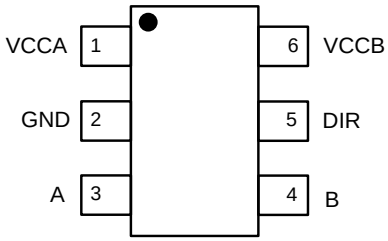
Features

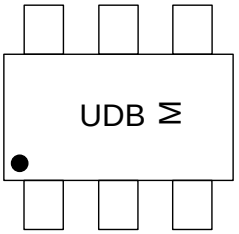
- Control Inputs V_{IH}/V_{IL} Levels Are Referenced to V_{CCA} Voltage
- V_{CC} Isolation Feature – If Either V_{CC} Input Is at GND, All Are in the High-Impedance State
- Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.65V to 5.5V Power-Supply Range
- Latch-Up Performance Exceeds 100 mA
- ESD Protection Exceeds ± 4kV Human-Body Model
- Available in SOT23-6 Package
- Max Data Rates
  220 Mbps (3.3V to 5.5V Translation)
  150 Mbps (3.3V to 1.8V Translation)

Logic Diagram (Positive Logic)



Pin Configurations Top View





M:Month Code
UM3601S
SOT23-6

Pin Descriptions

Pin No.	Pin Name	Function
1	V_{CCA}	A-port supply voltage. 1.65 V ≤ V_{CCA} ≤ 5.5 V.
2	GND	Ground.
3	A	Input/output A Referenced to V_{CCA}
4	B	Input/output B Referenced to V_{CCB}
5	DIR	Direction-control signal.
6	V_{CCB}	B-port supply voltage. 1.65 V ≤V_{CCB} ≤ 5.5 V.

Ordering Information

Part Number	Marking	Package Type	Shipping Qty
UM3601S	UDB	SOT23-6	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 +6.5	V
V_{CCB}	Supply Voltage Range		-0.5 to +6.5	V
V_I	Input Voltage Range (Note 2)	A ports	-0.5 to +6.5	V
		B ports	-0.5 to +6.5	
V_O	Voltage Range Applied to Any Output in the High-Impedance or Power-Off State (Note 2)	A ports	-0.5 to +6.5	V
		B ports	-0.5 to +6.5	
V_O	Voltage Range Applied to Any Output in the High or Low State (Note 2, 3)	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	℃
T_{STG}	Storage Temperature Range		-65 to +150	℃
T_J	Junction Temperature		-40 to +125	℃

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 input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.

Note 3: The value of V_{CCA} and V_{CCB} are provided in the recommended operating conditions table.

Package Thermal Impedance

Symbol	Parameter		Value	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance	SOT23-6	200.1	℃/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	SOT23-6	144.5	℃/W
$R_{\theta JB}$	Junction-to-board thermal resistance	SOT23-6	45.7	℃/W

ESD Rating

Symbol	Parameter	Value	Unit
ESD Protection	Human body model (HBM)	±4	kV

Recommended Operating Conditions (Note 1, 2, 3, 4)

Symbol	Parameter		V_{CCI}	V_{CCO}	Min	Max	Unit
V_{CCA}	Supply Voltage				1.65	5.5	V
V_{CCB}					1.65	5.5	
V_{IH}	High Level Input Voltage	Data Inputs(5)	1.65 V to 1.95 V		V_{CCI}×0.65		V
			2.3 V to 2.7 V		1.7		
			3 V to 3.6 V		2		
			4.5 V to 5.5 V		V_{CCI}×0.7		
V_{IL}	Low Level Input Voltage	Data Inputs(5)	1.65 V to 1.95 V			V_{CCI}×0.35	V
			2.3 V to 2.7 V			0.7	
			3 V to 3.6 V			0.8	
			4.5 V to 5.5 V			V_{CCI}×0.3	
V_{IH}	High Level Input Voltage	Control inputs (referenced to V_{CCA})(6)	1.65 V to 1.95 V		V_{CCI}×0.65		V
			2.3 V to 2.7 V		1.7		
			3 V to 3.6 V		2		
			4.5 V to 5.5 V		V_{CCI}×0.7		
V_{IL}	Low Level Input Voltage	Control inputs (referenced to V_{CCA})(6)	1.65 V to 1.95 V			V_{CCI}×0.35	V
			2.3 V to 2.7 V			0.7	
			3 V to 3.6 V			0.8	
			4.5 V to 5.5 V			V_{CCI}×0.3	
V_I	Input voltage	Control Inputs			0	5.5	V
$V_{I/O}$	Input/output voltage	Active state			0	V_{CCO}	V
		Three-State			0	5.5	
I_{OH}	High-level output current			1.65 V to 1.95 V		-4	mA
				2.3 V to 2.7 V		-8	
				3 V to 3.6 V		-24	
				4.5 V to 5.5 V		-32	
I_{OL}	Low-level output current			1.65 V to 1.95 V		4	mA
				2.3 V to 2.7 V		8	
				3 V to 3.6 V		24	
				4.5 V to 5.5 V		32	
Δt/ΔV	Input Transition Rise or Fall Time	Data Inputs	1.65 V to 1.95 V			20	ns/V
			2.3 V to 2.7 V			20	
			3 V to 3.6 V			10	
			4.5 V to 5.5 V			5	

Note 1:V_{CCI} is the V_{CC} associated with the data input port.
Note 2: V_{CCO} is the V_{CC} associated with the output port.
Note 3: All unused or driven (floating) data inputs (I/Os) of the device must be held at logic High or Low (preferably V_{CCI} or GND) to ensure proper device operation and minimize power.
Note 4: All unused control inputs must be held at V_{CCA} or GND to ensure proper device operation and minimize power comsumption.
Note 5: For V_{CCI} values not specified in the data sheet, V_{IH} min = V_{CCI} × 0.7 V, V_{IL} max = V_{CCI} × 0.3 V.
Note 6: For V_{CCA} values not specified in the data sheet, V_{IH} min = V_{CCA} × 0.7 V, V_{IL} max = V_{CCA} × 0.3 V.

Electrical Characteristics (Note 1, 2)

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

Parameter		Test Conditions	V_{CCA}	V_{CCB}	T_A=25 ℃	-40 ℃ to 85 ℃	Unit
					Typ Max	Min Max	
V_{OH}		I_{OH}=-100μA, V_I=V_{IH}	1.65V to 4.5V	1.65V to 4.5V		V_{CCO}-0.1	V
		I_{OH}=-4mA, V_I=V_{IH}	1.65V	1.65V		1.2	
		I_{OH}=-8mA, V_I=V_{IH}	2.3V	2.3V		1.9	
		I_{OH}=-24mA, V_I=V_{IH}	3V	3V		2.4	
		I_{OH}=-32mA, V_I=V_{IH}	4.5V	4.5V		3.8	
V_{OL}		I_{OL}=100μA, V_I=V_{IL}	1.65V to 4.5V	1.65V to 4.5V		0.1	V
		I_{OL}=4mA, V_I=V_{IL}	1.65V	1.65V		0.45	
		I_{OL}=8mA, V_I=V_{IL}	2.3V	2.3V		0.3	
		I_{OL}=24mA, V_I=V_{IL}	3V	3V		0.55	
		I_{OL}=32mA, V_I=V_{IL}	4.5V	4.5V		0.55	
I_I	DIR	V_I = V_{CCA} or GND	1.65V to 5.5V	1.65V to 5.5V	±1	±2	μA
I_{off}	A or B Port	V_I or V_O = 0 to 5.5 V	0V	0V to 5.5V	±1	±2	μA
			0V to 5.5V	0V	±1	±2	
I_{OZ}	A or B Port	V_O = V_{CCO} or GND	1.65V to 5.5V	1.65V to 5.5V	±1	±2	μA
I_{CCA}		V_I=V_{CCI} or GND I_O=0	1.65V to 5.5V	1.65 V to 5.5 V		3	μA
			5.5 V	0 V		2	
			0 V	5.5 V		-2	
I_{CCB}		V_I=V_{CCI} or GND I_O=0	1.65V to 5.5V	1.65 V to 5.5 V		3	μA
			5.5 V	0 V		-2	
			0 V	5.5 V		2	
I_{CCA}+I_{CCB}		V_I=V_{CCI} or GND I_O=0	1.65V to 5.5V	1.65V to 5.5V		4	μA
ΔI_{CCA}	A port	One A port at V_{CCA} – 0.6 V, DIR at V_{CCA}, B port = open	3V to 5.5V	3V to 5.5V		50	μA
	DIR	DIR at V_{CCA} – 0.6 V, B port = open, A port at V_{CCA} or GND				50	
ΔI_{CCB}	B port	One B port at V_{CCB} – 0.6 V, DIR at GND, A port = open	3V to 5.5V	3V to 5.5V		50	μA
C_i	DIR	V_I=V_{CCI} or GND	3.3V	3.3V	2.5		pF
C_{iO}	A or B Port	V_O = $V_{CCA/B}$ or GND	3.3V	3.3V	6		pF

Note 1: V_{CCI} is the supply voltage associated with the input port.

Note 2: V_{CCO} is the supply voltage associated with the output port.

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		V_{CCB}=2.5V ±0.2 V		V_{CCB}=3.3 ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
t_{PLH}	A	B	3	17.7	2.2	10.3	1.7	8.3	1.4	7.2	ns
t_{PHL}			2.8	14.3	2.2	8.5	1.8	7.1	1.7	7	
t_{PLH}	B	A	3	17.7	2.3	16	2.1	15.5	1.9	15.1	ns
t_{PHL}			2.8	14.3	2.1	12.9	2	12.6	1.8	12.2	
t_{PHZ}	DIR	A	5.2	19.4	4.8	18.5	4.7	18.4	5.1	17.5	ns
t_{PLZ}			2.3	18	2.1	17.1	2.4	15.2	3.1	15.7	
t_{PHZ}	DIR	B	7.4	21.9	4.9	11.5	4.6	10.3	2.8	9.4	ns
t_{PLZ}			4.2	16	3.7	11.7	3.3	10.6	2.4	9.1	
t_{PZH}	DIR	A		33.7		25.2		23.9		23.1	ns
t_{PZL}				36.2		24.4		22.9		20.4	
t_{PZH}	DIR	B		28.2		23.4		22.8		20.9	ns
t_{PZL}				33.7		27		25.5		24.1	

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}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2 V		V_{CCB}=3.3 ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
t_{PLH}	A	B	2.3	16	1.5	8.5	1.7	6.4	1.1	5.1	ns
t_{PHL}			2.1	12.9	1.4	7.5	1.3	5.4	0.9	4.6	
t_{PLH}	B	A	2.2	10.3	1.5	8.5	1.4	8	1	7.5	ns
t_{PHL}			2.2	8.5	1.4	7.5	1.3	7	0.9	6.2	
t_{PHZ}	DIR	A	3	14.5	3.1	13.4	2.8	12.2	3.2	12.7	ns
t_{PLZ}			1.3	14.5	1.3	14.5	1.3	11.8	1	11.8	
t_{PHZ}	DIR	B	6.5	23.7	4.1	11.4	3.9	10.2	2.4	7.1	ns
t_{PLZ}			3.9	18.9	3.2	9.6	2.8	8.4	1.8	7.2	
t_{PZH}	DIR	A		29.2		18.1		16.4		12.8	ns
t_{PZL}				32.2		18.9		17.2		13.3	
t_{PZH}	DIR	B		21.9		14.4		15.8		14.3	ns
t_{PZL}				21		15.6		13.5		13.5	

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}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2 V		V_{CCB}=3.3 ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
t_{PLH}	A	B	2.1	15.5	1.4	8	0.7	5.8	0.7	4.4	ns
t_{PHL}			2	12.6	1.3	7	0.8	5	0.7	4	
t_{PLH}	B	A	1.7	8.3	1.3	6.4	0.7	5.8	0.6	5.4	ns
t_{PHL}			1.8	7.1	1.3	5.4	0.8	5	0.7	4.5	
t_{PHZ}	DIR	A	2.9	13.2	3	11.1	2.8	10.6	3.4	10.6	ns
t_{PLZ}			1.8	13.3	1.6	12.2	2.2	9.8	2.2	9.0	
t_{PHZ}	DIR	B	5.4	20.5	3.9	10.1	2.9	8.8	2.4	6.8	ns
t_{PLZ}			3.3	14.5	2.9	9.7	2.4	7.1	1.7	6.9	
t_{PZH}	DIR	A		22.8		14.2		12.9		10.3	ns
t_{PZL}				27.6		15.5		13.8		11.3	
t_{PZH}	DIR	B		21.1		13.6		11.5		11.5	ns
t_{PZL}				19.9		14.3		12.3		11.3	

Switching Characteristics

Over recommended operating free-air temperature range, V_{CCA}= 5V ±0.5V (unless otherwise noted)

Parameter	From (Input)	To (Output)	V_{CCB}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2 V		V_{CCB}=3.3 ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
t_{PLH}	A	B	1.9	15.1	1	7.5	0.6	5.4	0.5	3.9	ns
t_{PHL}			1.8	12.2	0.9	6.2	0.7	4.5	0.5	3.5	
t_{PLH}	B	A	1.4	7.2	1	5.1	0.7	4.4	0.5	3.9	ns
t_{PHL}			1.7	7	0.9	4.6	0.7	4	0.5	3.5	
t_{PHZ}	DIR	A	2.1	5.4	2.2	5.4	2.2	5.5	2.2	5.4	ns
t_{PLZ}			0.9	3.8	1	3.8	1	3.7	0.9	3.7	
t_{PHZ}	DIR	B	4.8	20.2	2.5	9.8	1	8.5	2.5	6.5	ns
t_{PLZ}			4.2	14.8	2.5	7.4	2.5	7	1.6	4.5	
t_{PZH}	DIR	A		22		12.5		11.4		8.4	ns
t_{PZL}				27.2		14.4		12.5		10	
t_{PZH}	DIR	B		18.9		12.6		11.4		10.7	ns
t_{PZL}				17.6		12.8		12.2		10.9	

Operating Characteristics

T_A=25℃

Parameter		Test Conditions	V_{CCA}= V_{CCB} =1.8V	V_{CCA}= V_{CCB} =2.5V	V_{CCA}= V_{CCB} =3.3V	V_{CCA}= V_{CCB} =5V	Unit
			TYP	TYP	TYP	TYP	
C_{pdA} (1)	A-port input, B-port output	C_L = 0, f = 10 MHz, t_r = t_f = 1 ns	3	4	4	4	pF
	B-port input, A-port output		18	19	20	21	
C_{pdB} (1)	A-port input, B-port output		18	19	20	21	
	B-port input, A-port output		3	4	4	4	

(1) Power dissipation capacitance per transceiver

Typical Characteristics

T_A=25 ℃,V_{CCA}=1.8V

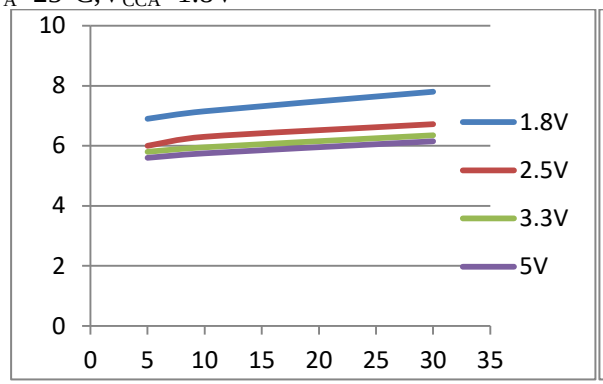


Figure 1. Typical Propagation Delay (A to B) vs Load Capacitance

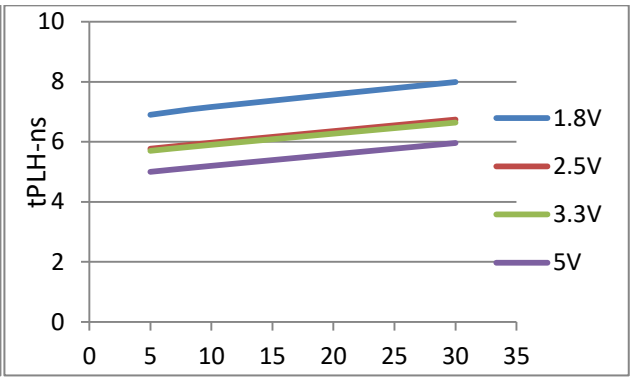


Figure 2. Typical Propagation Delay (B to A) vs Load Capacitance

T_A=25 ℃,V_{CCA}=2.5V

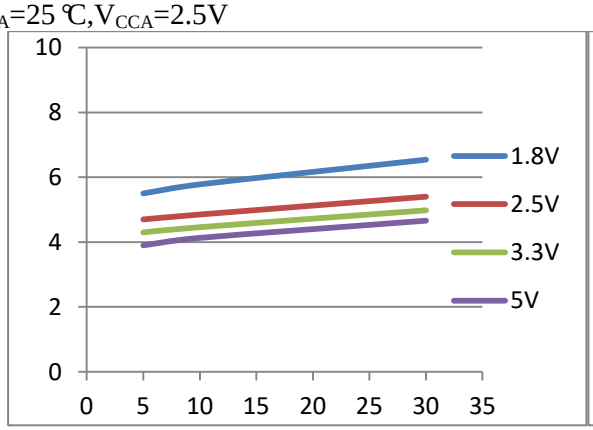


Figure 3. Typical Propagation Delay (A to B) vs Load Capacitance

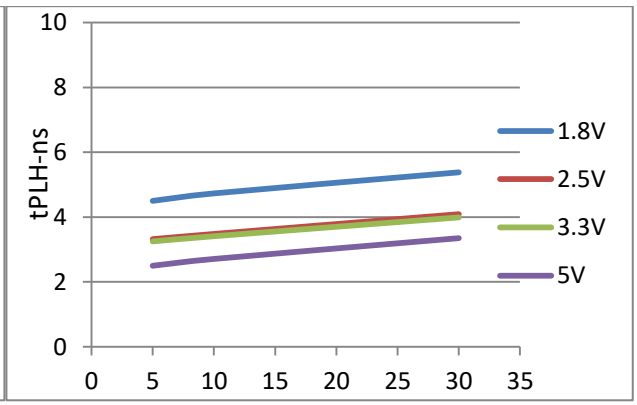


Figure 4. Typical Propagation Delay (B to A) vs Load Capacitance

T_A=25 ℃,V_{CCA}=3.3V

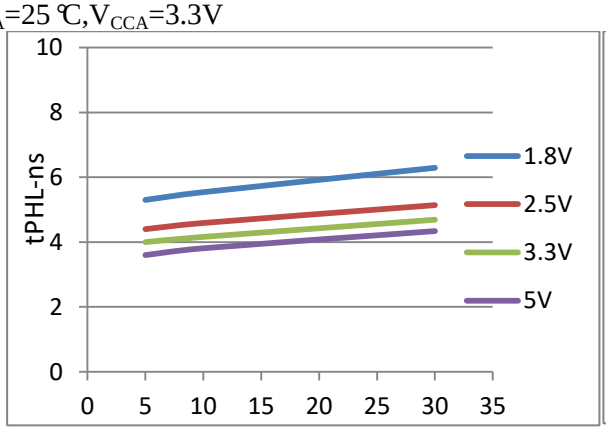


Figure 5. Typical Propagation Delay (A to B) vs Load Capacitance

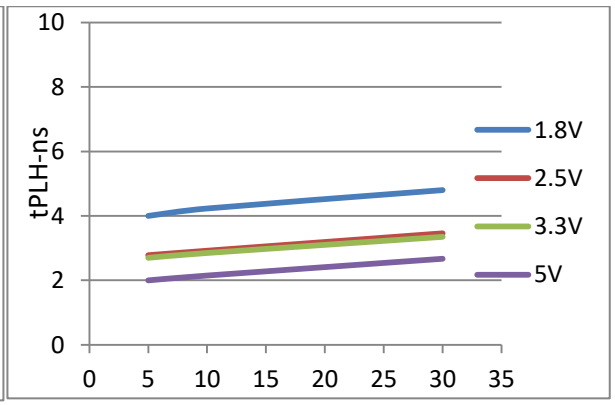


Figure 6. Typical Propagation Delay (B to A) vs Load Capacitance

T_A=25 ℃,V_{CCA}=5V

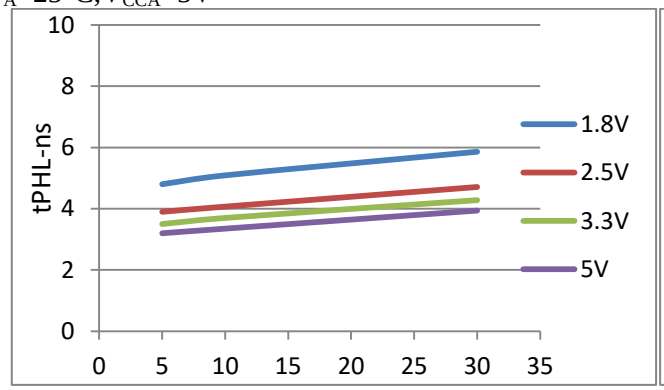


Figure 7. Typical Propagation Delay (A to B) vs Load Capacitance

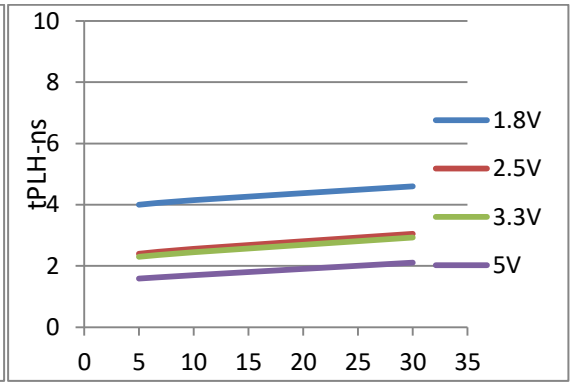
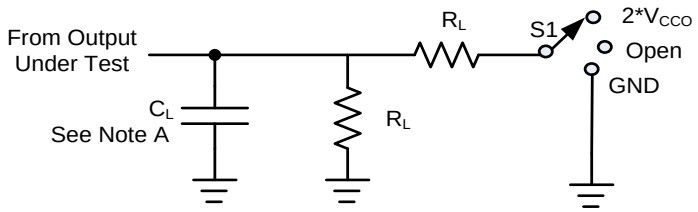


Figure 8. Typical Propagation Delay (B to A) vs Load Capacitance

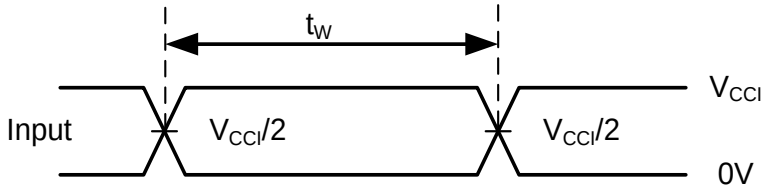
Parameter Measurement Information



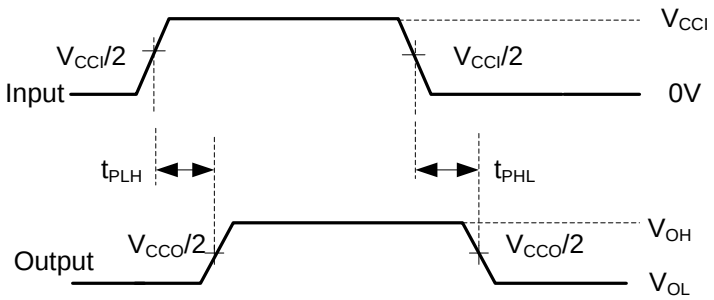
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 ×V_{CCO}
t_{PHZ}/t_{PZH}	GND

Load Current

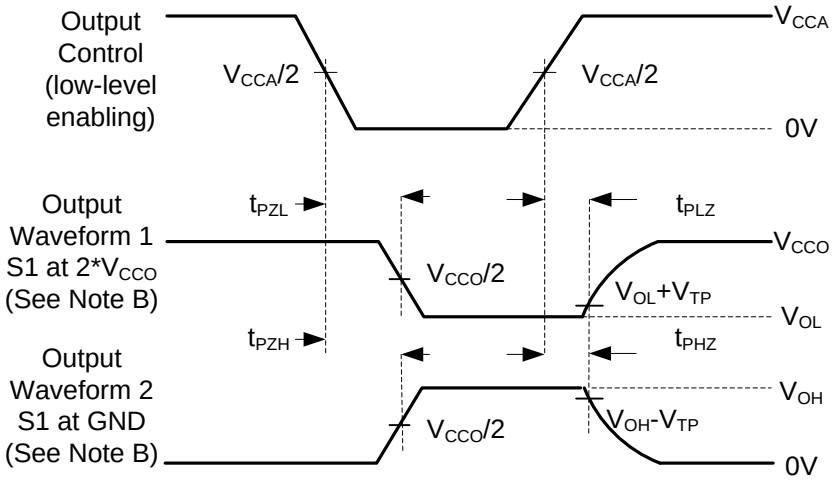
V_{CCO}	C_L	R_L	V_{TP}
1.8 V ±0.15 V	15PF	2kΩ	0.15V
2.5V ±0.2V	15PF	2kΩ	0.15V
3.3V ±0.3V	15PF	2kΩ	0.3V
5V ±0.5V	15PF	2kΩ	0.3V



Voltage Waveforms Pulse Duration



Voltage Waveforms Propagation Delay Times



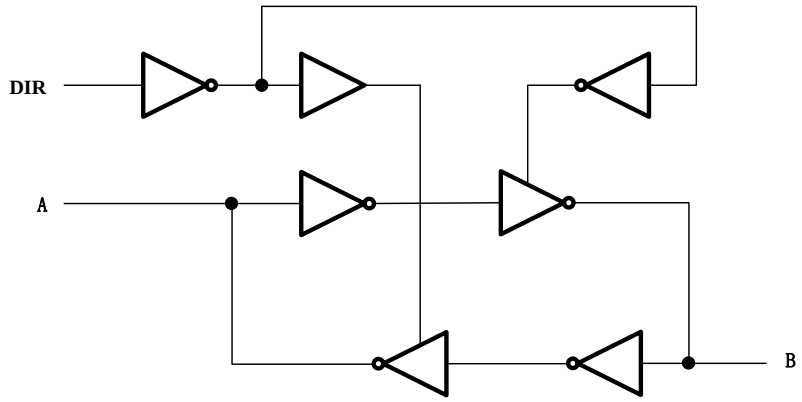
Voltage Waveforms Enable and Disable Times

NOTES:
A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR≤10 MHz, Z_O = 50Ω, dv/dt≥1V/ns.
D. The outputs are measured one at a time, with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. V_{CCI} is the V_{CC} associated with the input port.
I. V_{CCO} is the V_{CC} associated with the output port.
J. All parameters and waveforms are not applicable to all devices.

Detailed Description

The UM3601 is a single-bit, dual supply non-inverting transceiver. Pin A and direction control pin are support by V_{CCA} and pin B is support by V_{CCB}. The A port is able to accept I/O voltages ranging from 1.65 V to 5.5 V, while the B port can accept I/O voltages from 1.65 V to 5.5 V. The high on DIR allows data transmission from A to B and a low on DIR allows data transmission from B to A.

Functional Block Diagram



Logic Diagram (Positive Logic)

Feature Description

Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.65V to 5.5V Power-Supply Range

Both V_{CCA} and V_{CCB} can be supplied at any voltage between 1.65V and 5.5V making the device suitable for translating between any of the voltage nodes (1.8V, 2.5V, 3.3V and 5V).

I_{off} Supports Partial-Power-Down Mode Operation

I_{off} prevents backflow current by disabling I/O output circuits when device is in partial-power-down mode.

Device Functional Modes

The UM3601 is bus transceiver that can operate from 1.65V to 5.5V (V_{CCA}) and 1.65V to 5.5V (V_{CCB}). The signal translation between 1.65V and 5.5V requires direction control and output enable control. When DIR is high, data transmission is from A to B. When DIR is low, data transmission is from B to A.

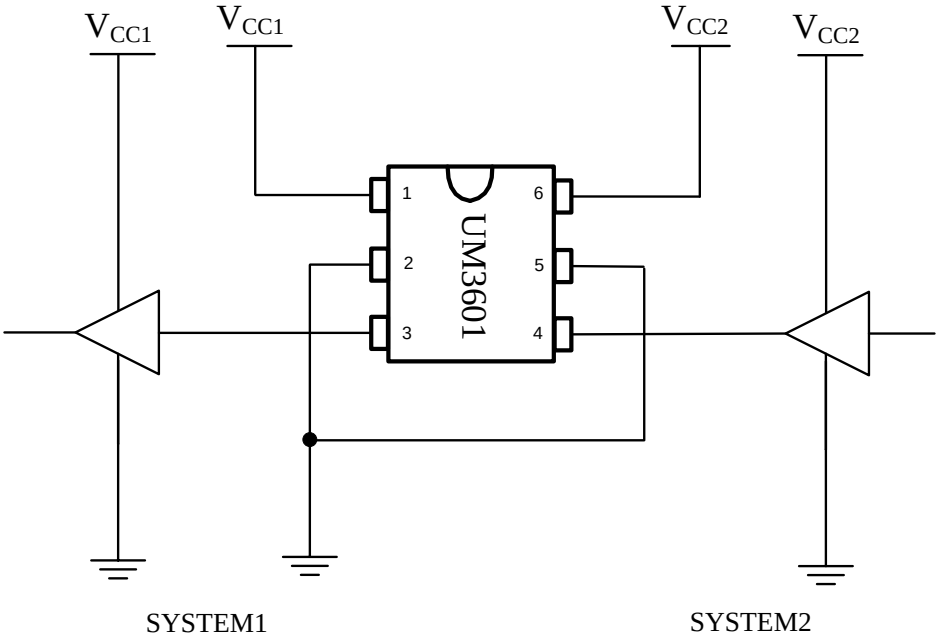
Table 1. Function Table(1)

INPUTS DIR	OPERATION
L H	B data to A bus A data to B bus

(1) Input circuits of the data I/Os are always active.

Application Information

The UM3601 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The maximum output current can be up to 32 mA when device is powered by 5.5 V.

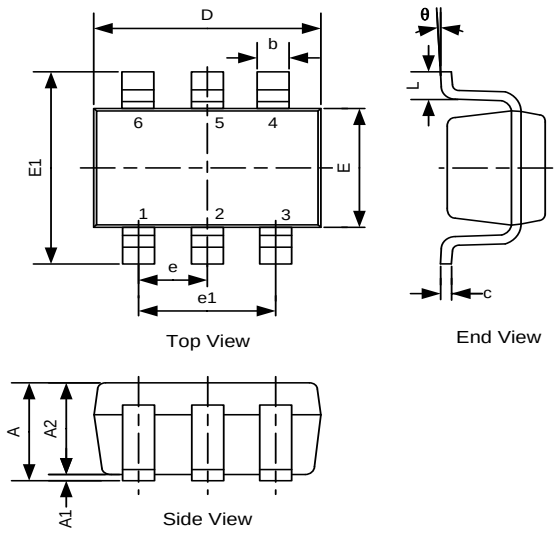


Typical Application Circuit

Package Information

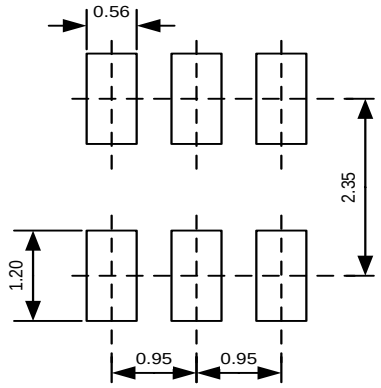
UM3601S SOT23-6

Outline Drawing



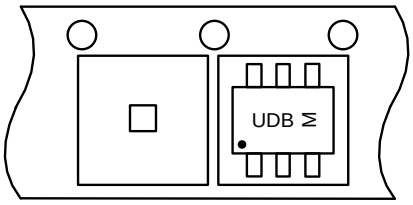
DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	1.013	1.15	1.40	0.040	0.045	0.055
A1	0.00	0.05	0.10	0.000	0.002	0.004
A2	1.00	1.10	1.30	0.039	0.043	0.051
b	0.30	-	0.50	0.012	-	0.020
c	0.10	0.15	0.20	0.004	0.006	0.008
D	2.82	-	3.10	0.111	-	0.122
E	1.50	1.60	1.70	0.059	0.063	0.067
E1	2.60	2.80	3.00	0.102	0.110	0.118
e	0.95REF			0.037REF		
e1	1.90REF			0.075REF		
L	0.30	-	0.60	0.012	-	0.024
θ	0 °	-	8 °	0 °	-	8 °

Land Pattern

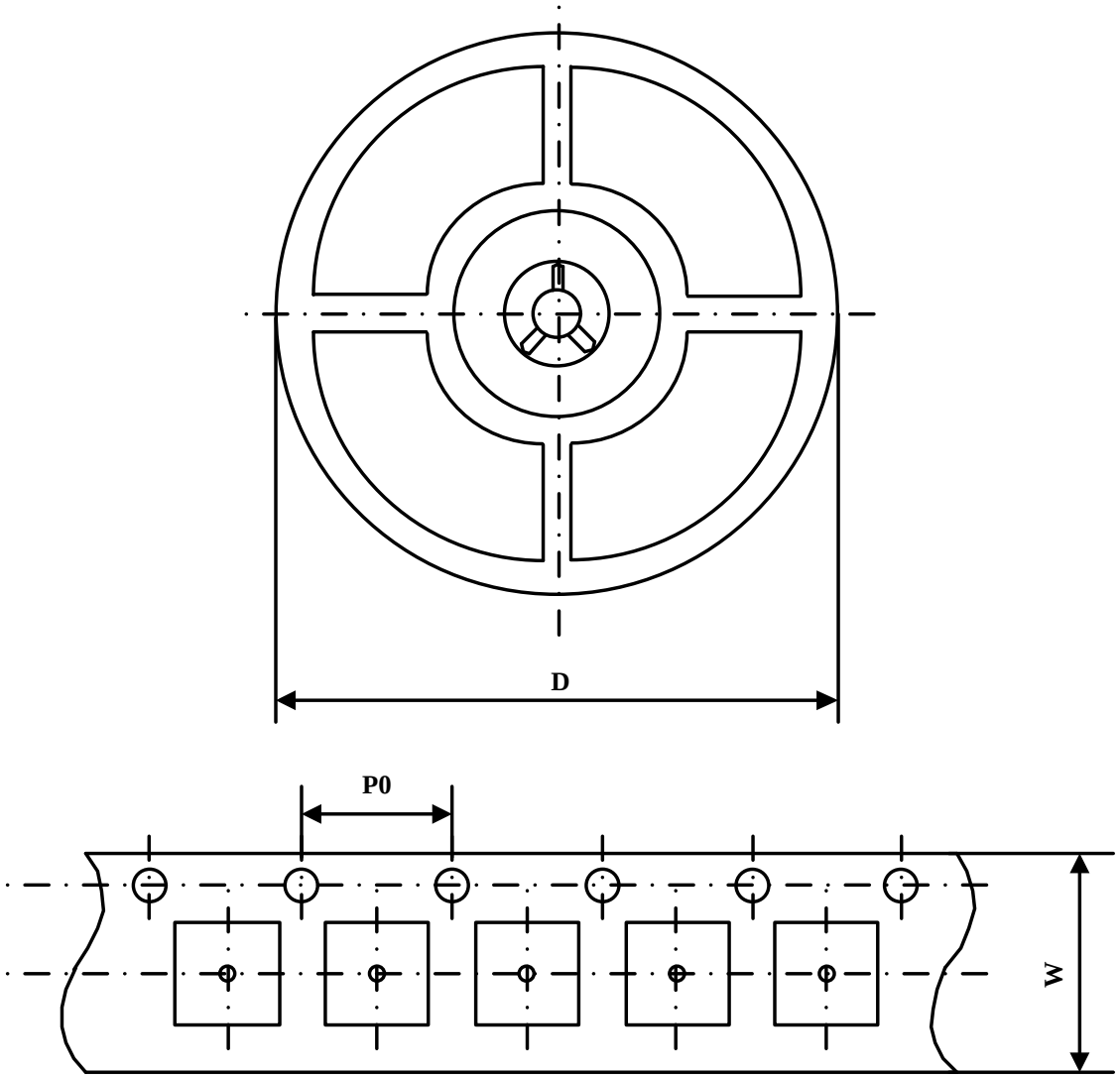


NOTES:
1. Compound dimension: 2.92×1.60;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

Tape and Reel Orientation



Packing Information



Part Number	Package Type	Carrier Width(W)	Pitch(P0)	Reel Size(D)
UM3601S	SOT23-6	8 mm	4 mm	180 mm

GREEN COMPLIANCE

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