



# Low Voltage, 1.15 V to 5.5 V, 4-Channel, Bidirectional Logic Level Translator

## ADG3304-EP

### FEATURES

- Bidirectional level translation
- Operates from 1.15 V to 5.5 V
- Low quiescent current < 5  $\mu$ A
- No direction pin
- Supports defense and aerospace applications (AQEC standard)
- Military temperature range:  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- Controlled manufacturing baseline
- One assembly and test site
- One fabrication site
- Enhanced product change notification
- Qualification data available on request

### APPLICATIONS

- SPI<sup>®</sup>, MICROWIRE<sup>™</sup> level translation
- Low voltage ASIC level translation
- Smart card readers
- Cell phones and cell phone cradles
- Portable communications devices
- Telecommunications equipment
- Network switches and routers
- Storage systems (SAN/NAS)

### GENERAL DESCRIPTIONS

The ADG3304-EP is a bidirectional logic level translator that contains four bidirectional channels. It can be used in multivoltage digital system applications, such as data transfer, between a low voltage digital signal processing controller and a higher voltage device using SPI and MICROWIRE interfaces. The internal architecture allows the device to perform bidirectional logic level translation without an additional signal to set the direction in which the translation takes place.

The voltage applied to  $V_{CCA}$  sets the logic levels on the A side of the device, while  $V_{CCY}$  sets the levels on the Y side. For proper operation,  $V_{CCA}$  must always be less than  $V_{CCY}$ . The  $V_{CCA}$ -compatible logic signals applied to the A side of the device appear as  $V_{CCY}$ -compatible levels on the Y side. Similarly,  $V_{CCY}$ -compatible

### FUNCTIONAL BLOCK DIAGRAM

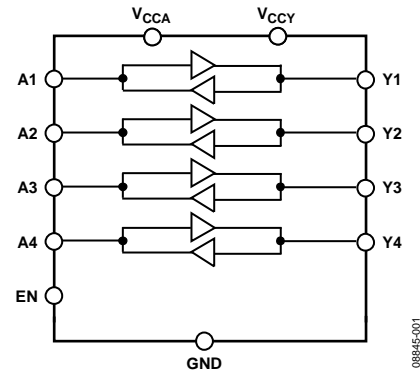


Figure 1.

logic levels applied to the Y side of the device appear as  $V_{CCA}$ -compatible logic levels on the A side.

The enable pin (EN) provides three-state operation on both the A side and the Y side pins. When the EN pin is pulled low, the terminals on both sides of the device are in the high impedance state. The EN pin is referred to the  $V_{CCA}$  supply voltage and driven high for normal operation.

The ADG3304-EP is available in compact 14-lead TSSOP package.

Full details about this enhanced product are available in the [ADG3304](#) data sheet, which should be consulted in conjunction with this data sheet.

#### Rev. 0

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## REVISION HISTORY

**10/10—Revision 0: Initial Version**

## SPECIFICATIONS

$V_{CCY} = 1.65\text{ V to }5.5\text{ V}$ ,  $V_{CCA} = 1.15\text{ V to }V_{CCY}$ ,  $GND = 0\text{ V}$ ,  $T_A = -55^\circ\text{C to }+125^\circ\text{C}$  unless otherwise noted.

**Table 1.**

Parameter	Symbol	Test Conditions/Comments	Min	Typ <sup>1</sup>	Max	Unit
LOGIC INPUTS/OUTPUTS						
A Side						
Input High Voltage <sup>2</sup>	$V_{IHA}$	$V_{CCA} = 1.2\text{ V} + 0.1\text{ V}/-0.05\text{ V}$ $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$ $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ $V_{CCA} = 5\text{ V} \pm 0.5\text{ V}$	$V_{CCA} \times 0.88$ $V_{CCA} \times 0.72$ 1.7 2.2 $V_{CCA} \times 0.7$			V V V V V
Input Low Voltage <sup>2</sup>	$V_{ILA}$	$V_{CCA} = 1.2\text{ V} + 0.1\text{ V}/-0.05\text{ V}$ $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$ $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ $V_{CCA} = 5\text{ V} \pm 0.5\text{ V}$			$V_{CCA} \times 0.35$ $V_{CCA} \times 0.35$ 0.7 0.8 $V_{CCA} \times 0.3$	V V V V V
Output High Voltage	$V_{OHA}$	$V_Y = V_{CCY}$ , $I_{OH} = 20\ \mu\text{A}$	$V_{CCA} - 0.4$			V
Output Low Voltage	$V_{OLA}$	$V_Y = 0\text{ V}$ , $I_{OL} = 20\ \mu\text{A}$			0.4	V
Capacitance <sup>2</sup>	$C_A$	$f = 1\text{ MHz}$ , $EN = 0$		9		pF
Leakage Current	$I_{LA, HI-Z}$	$V_A = 0\text{ V}/V_{CCA}$ , $EN = 0$			$\pm 1$	$\mu\text{A}$
Y Side						
Input High Voltage <sup>2</sup>	$V_{IHY}$	$V_{CCY} = 1.8\text{ V} \pm 0.15\text{ V}$ $V_{CCY} = 2.5\text{ V} \pm 0.2\text{ V}$ $V_{CCY} = 3.3\text{ V} \pm 0.3\text{ V}$ $V_{CCY} = 5\text{ V} \pm 0.5\text{ V}$	$V_{CCY} \times 0.67$ 1.7 2 $V_{CCY} \times 0.7$			V V V V
Input Low Voltage <sup>2</sup>	$V_{ILY}$	$V_{CCY} = 1.8\text{ V} \pm 0.15\text{ V}$ $V_{CCY} = 2.5\text{ V} \pm 0.2\text{ V}$ $V_{CCY} = 3.3\text{ V} \pm 0.3\text{ V}$ $V_{CCY} = 5\text{ V} \pm 0.5\text{ V}$			$V_{CCY} \times 0.35$ 0.7 0.8 $V_{CCY} \times 0.25$	V V V V
Output High Voltage	$V_{OHY}$	$V_A = V_{CCA}$ , $I_{OH} = 20\ \mu\text{A}$	$V_{CCY} - 0.4$			V
Output Low Voltage	$V_{OLY}$	$V_A = 0\text{ V}$ , $I_{OL} = 20\ \mu\text{A}$			0.4	V
Capacitance <sup>2</sup>	$C_Y$	$f = 1\text{ MHz}$ , $EN = 0$		6		pF
Leakage Current	$I_{LY, HI-Z}$	$V_Y = 0\text{ V}/V_{CCY}$ , $EN = 0$			$\pm 1$	$\mu\text{A}$
Enable (EN)						
Input High Voltage <sup>2</sup>	$V_{IHEN}$	$V_{CCA} = 1.2\text{ V} + 0.1\text{ V}/-0.05\text{ V}$ $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$ $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ $V_{CCA} = 5\text{ V} \pm 0.5\text{ V}$	$V_{CCA} \times 0.88$ $V_{CCA} \times 0.72$ 1.7 2.2 $V_{CCA} \times 0.7$			V V V V V
Input Low Voltage <sup>2</sup>	$V_{ILEN}$	$V_{CCA} = 1.2\text{ V} + 0.1\text{ V}/-0.05\text{ V}$ $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$ $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ $V_{CCA} = 5\text{ V} \pm 0.5\text{ V}$			$V_{CCA} \times 0.35$ $V_{CCA} \times 0.35$ 0.7 0.8 $V_{CCA} \times 0.3$	V V V V V
Leakage Current	$I_{LEN}$	$V_{EN} = 0\text{ V}/V_{CCA}$ , $V_A = 0\text{ V}$			$\pm 1$	$\mu\text{A}$
Capacitance <sup>2</sup>	$C_{EN}$			3		pF
Enable Time <sup>2</sup>	$t_{EN}$	$R_S = R_T = 50\ \Omega$ $V_A = 0\text{ V}/V_{CCA}$ (A $\rightarrow$ Y) $V_Y = 0\text{ V}/V_{CCY}$ (Y $\rightarrow$ A)		1	1.8	$\mu\text{s}$

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Parameter	Symbol	Test Conditions/Comments	Min	Typ <sup>1</sup>	Max	Unit
<b>SWITCHING CHARACTERISTICS<sup>2</sup></b>						
<b>3.3 V ± 0.3 V ≤ V<sub>CCA</sub> ≤ V<sub>CCY</sub>, V<sub>CCY</sub> = 5 V ± 0.5 V</b>						
A→Y Level Translation		R <sub>S</sub> = R <sub>T</sub> = 50 Ω, C <sub>L</sub> = 50 pF				
Propagation Delay	t <sub>P, A→Y</sub>			6	15	ns
Rise Time	t <sub>R, A→Y</sub>			2	5	ns
Fall Time	t <sub>F, A→Y</sub>			2	5	ns
Maximum Data Rate	D <sub>MAX, A→Y</sub>			50		Mbps
Channel-to-Channel Skew	t <sub>SKREW, A→Y</sub>			2		ns
Part-to-Part Skew	t <sub>PPSKEW, A→Y</sub>			3		ns
Y→A Level Translation		R <sub>S</sub> = R <sub>T</sub> = 50 Ω, C <sub>L</sub> = 15 pF				
Propagation Delay	t <sub>P, Y→A</sub>			4	10	ns
Rise Time	t <sub>R, Y→A</sub>			1	5	ns
Fall Time	t <sub>F, Y→A</sub>			3	10	ns
Maximum Data Rate	D <sub>MAX, Y→A</sub>			50		Mbps
Channel-to-Channel Skew	t <sub>SKREW, Y→A</sub>			2		ns
Part-to-Part Skew	t <sub>PPSKEW, Y→A</sub>			2		ns
<b>1.8 V ± 0.15 V ≤ V<sub>CCA</sub> ≤ V<sub>CCY</sub>, V<sub>CCY</sub> = 3.3 V ± 0.3 V</b>						
A→Y Translation		R <sub>S</sub> = R <sub>T</sub> = 50 Ω, C <sub>L</sub> = 50 pF				
Propagation Delay	t <sub>P, A→Y</sub>			8	15	ns
Rise Time	t <sub>R, A→Y</sub>			2	8	ns
Fall Time	t <sub>F, A→Y</sub>			2	8	ns
Maximum Data Rate	D <sub>MAX, A→Y</sub>			50		Mbps
Channel-to-Channel Skew	t <sub>SKREW, A→Y</sub>			2		ns
Part-to-Part Skew	t <sub>PPSKEW, A→Y</sub>			4		ns
Y→A Translation		R <sub>S</sub> = R <sub>T</sub> = 50 Ω, C <sub>L</sub> = 15 pF				
Propagation Delay	t <sub>P, Y→A</sub>			5	12	ns
Rise Time	t <sub>R, Y→A</sub>			2	5	ns
Fall Time	t <sub>F, Y→A</sub>			2	5	ns
Maximum Data Rate	D <sub>MAX, Y→A</sub>			50		Mbps
Channel-to-Channel Skew	t <sub>SKREW, Y→A</sub>			2		ns
Part-to-Part Skew	t <sub>PPSKEW, Y→A</sub>			3		ns
<b>1.15 V to 1.3 V ≤ V<sub>CCA</sub> ≤ V<sub>CCY</sub>, V<sub>CCY</sub> = 3.3 V ± 0.3 V</b>						
A→Y Translation		R <sub>S</sub> = R <sub>T</sub> = 50 Ω, C <sub>L</sub> = 50 pF				
Propagation Delay	t <sub>P, A→Y</sub>			9	27	ns
Rise Time	t <sub>R, A→Y</sub>			3	8	ns
Fall Time	t <sub>F, A→Y</sub>			2	8	ns
Maximum Data Rate	D <sub>MAX, A→Y</sub>			40		Mbps
Channel-to-Channel Skew	t <sub>SKREW, A→Y</sub>			2		ns
Part-to-Part Skew	t <sub>PPSKEW, A→Y</sub>			10		ns
Y→A Translation		R <sub>S</sub> = R <sub>T</sub> = 50 Ω, C <sub>L</sub> = 15 pF				
Propagation Delay	t <sub>P, Y→A</sub>			5	13	ns
Rise Time	t <sub>R, Y→A</sub>			2	6	ns
Fall Time	t <sub>F, Y→A</sub>			2	6	ns
Maximum Data Rate	D <sub>MAX, Y→A</sub>			40		Mbps
Channel-to-Channel Skew	t <sub>SKREW, Y→A</sub>			2		ns
Part-to-Part Skew	t <sub>PPSKEW, Y→A</sub>			4		ns

Parameter	Symbol	Test Conditions/Comments	Min	Typ <sup>1</sup>	Max	Unit
1.15 V to 1.3 V $\leq V_{CCA} \leq V_{CCY}$ , $V_{CCY} = 1.8 \text{ V} \pm 0.3 \text{ V}$						
A→Y Translation						
Propagation Delay	$t_{P, A \rightarrow Y}$	$R_S = R_T = 50 \Omega$ , $C_L = 50 \text{ pF}$		12	35	ns
Rise Time	$t_{R, A \rightarrow Y}$			7	18	ns
Fall Time	$t_{F, A \rightarrow Y}$			3	8	ns
Maximum Data Rate	$D_{MAX, A \rightarrow Y}$			25		Mbps
Channel-to-Channel Skew	$t_{SKEW, A \rightarrow Y}$			2		ns
Part-to-Part Skew	$t_{PPSKEW, A \rightarrow Y}$			15		ns
Y→A Translation						
Propagation Delay	$t_{P, Y \rightarrow A}$	$R_S = R_T = 50 \Omega$ , $C_L = 15 \text{ pF}$		14	40	ns
Rise Time	$t_{R, Y \rightarrow A}$			5	24	ns
Fall Time	$t_{F, Y \rightarrow A}$			2.5	10	ns
Maximum Data Rate	$D_{MAX, Y \rightarrow A}$			25		Mbps
Channel-to-Channel Skew	$t_{SKEW, Y \rightarrow A}$			3		ns
Part-to-Part Skew	$t_{PPSKEW, Y \rightarrow A}$			23.5		ns
2.5 V $\pm 0.2 \text{ V} \leq V_{CCA} \leq V_{CCY}$ , $V_{CCY} = 3.3 \text{ V} \pm 0.3 \text{ V}$						
A→Y Translation						
Propagation Delay	$t_{P, A \rightarrow Y}$	$R_S = R_T = 50 \Omega$ , $C_L = 50 \text{ pF}$		7	15	ns
Rise Time	$t_{R, A \rightarrow Y}$			2.5	6	ns
Fall Time	$t_{F, A \rightarrow Y}$			2	8	ns
Maximum Data Rate	$D_{MAX, A \rightarrow Y}$			60		Mbps
Channel-to-Channel Skew	$t_{SKEW, A \rightarrow Y}$			1.5		ns
Part-to-Part Skew	$t_{PPSKEW, A \rightarrow Y}$			4		ns
Y→A Translation						
Propagation Delay	$t_{P, Y \rightarrow A}$	$R_S = R_T = 50 \Omega$ , $C_L = 15 \text{ pF}$		5	12	ns
Rise Time	$t_{R, Y \rightarrow A}$			1	6	ns
Fall Time	$t_{F, Y \rightarrow A}$			3	8	ns
Maximum Data Rate	$D_{MAX, Y \rightarrow A}$			60		Mbps
Channel-to-Channel Skew	$t_{SKEW, Y \rightarrow A}$			2		ns
Part-to-Part Skew	$t_{PPSKEW, Y \rightarrow A}$			3		ns
<b>POWER REQUIREMENTS</b>						
Power Supply Voltages	$V_{CCA}$	$V_{CCA} \leq V_{CCY}$	1.15		5.5	V
	$V_{CCY}$		1.65		5.5	V
Quiescent Power Supply Current	$I_{CCA}$	$V_A = 0 \text{ V}/V_{CCA}$ , $V_Y = 0 \text{ V}/V_{CCY}$ , $V_{CCA} = V_{CCY} = 5.5 \text{ V}$ , $EN = 1$		0.17	5	$\mu\text{A}$
	$I_{CCY}$	$V_A = 0 \text{ V}/V_{CCA}$ , $V_Y = 0 \text{ V}/V_{CCY}$ , $V_{CCA} = V_{CCY} = 5.5 \text{ V}$ , $EN = 1$		0.27	5	$\mu\text{A}$
Three-State Mode Power Supply Current	$I_{HI-Z, A}$	$V_{CCA} = V_{CCY} = 5.5 \text{ V}$ , $EN = 0$		0.1	5	$\mu\text{A}$
	$I_{HI-Z, Y}$	$V_{CCA} = V_{CCY} = 5.5 \text{ V}$ , $EN = 0$		0.1	5	$\mu\text{A}$

<sup>1</sup>  $T_A$  for typical specifications is +25°C.

<sup>2</sup> Guaranteed by design, not production tested.

## ABSOLUTE MAXIMUM RATINGS

T<sub>A</sub> = 25°C, unless otherwise noted.

**Table 2.**

Parameter	Rating
V <sub>CCA</sub> to GND	−0.3 V to +7 V
V <sub>CCY</sub> to GND	V <sub>CCA</sub> to +7 V
Digital Inputs (A)	−0.3 V to (V <sub>CCA</sub> + 0.3 V)
Digital Inputs (Y)	−0.3 V to (V <sub>CCY</sub> + 0.3 V)
EN to GND	−0.3 V to +7 V
Operating Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature	150°C
θ <sub>JA</sub> Thermal Impedance (4-Layer Board) 14-Lead TSSOP	112.6°C/W
Lead Temperature, Soldering	
Vapor phase(60 sec)	215°C
Infrared (15 sec)	220°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Only one absolute maximum rating can be applied at any one time.

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

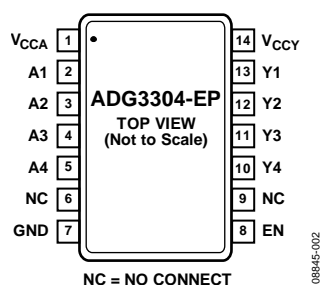


Figure 2. 14-Lead TSSOP  
Pin Configuration

**Table 3. 14-Lead TSSOP Pin Function Descriptions**

Pin No.	Mnemonic	Description
1	V <sub>CCA</sub>	Power Supply Voltage Input for the A1 to A4 I/O Pins ( $1.15\text{ V} \leq V_{CCA} \leq V_{CCY}$ ).
2	A1	Input/Output A1. Referenced to V <sub>CCA</sub> .
3	A2	Input/Output A2. Referenced to V <sub>CCA</sub> .
4	A3	Input/Output A3. Referenced to V <sub>CCA</sub> .
5	A4	Input/Output A4. Referenced to V <sub>CCA</sub> .
6, 9	NC	No Connect.
7	GND	Ground.
8	EN	Active High Enable Input.
10	Y4	Input/Output Y4. Referenced to V <sub>CCY</sub> .
11	Y3	Input/Output Y3. Referenced to V <sub>CCY</sub> .
12	Y2	Input/Output Y2. Referenced to V <sub>CCY</sub> .
13	Y1	Input/Output Y1. Referenced to V <sub>CCY</sub> .
14	V <sub>CCY</sub>	Power Supply Voltage Input for the Y1 to Y4 I/O Pins ( $1.65\text{ V} \leq V_{CC} \leq 5.5\text{ V}$ ).

**Table 4. Truth Table**

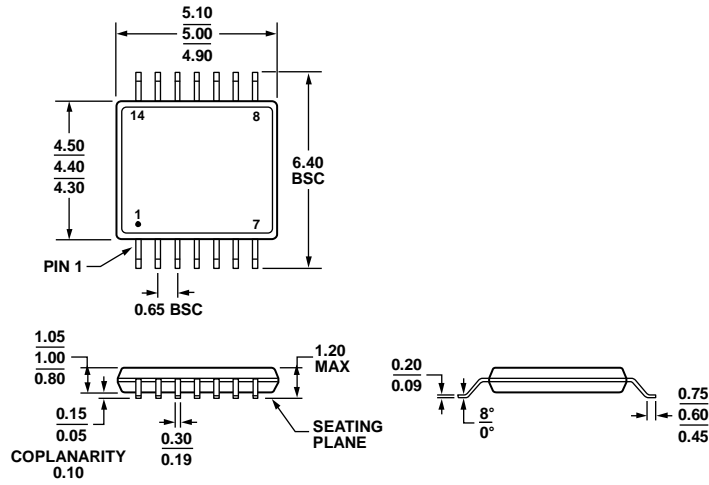
EN	Y I/O Pins	A I/O Pins
0	Hi-Z <sup>1</sup>	Hi-Z <sup>1</sup>
1	Normal operation <sup>2</sup>	Normal operation <sup>2</sup>

<sup>1</sup> High impedance state.

<sup>2</sup> In normal operation, the ADG3304-EP performs level translation.

# ADG3304-EP

## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB-1

Figure 3. 14-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-14)

Dimensions shown in millimeters

061908-A

## ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADG3304SRU-EP-RL7	-55°C to +125°C	14-Lead Thin Shrink Small Outline Package [TSSOP]	RU-14