

## SN74AVC2T872

SCES710-NOVEMBER 2008

# VOLTAGE-LEVEL SHIFTER FOR IC-USB INTERFACE

#### **FEATURES**

- V<sub>CCA</sub>, V<sub>CCB</sub> Supply Voltage: 1.1 V to 3.6 V
- When V<sub>CCB</sub> = 0 V, A-Port is Disabled and B-Port is Held at GND Through 120-kΩ Pulldown
- Crossover Skew of <1 ns
- Meets All Requirements of the IC-USB Standard
- Small Package: 0.4 mm pitch WCSP (1.2 mm × 1.6 mm)
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II ESD Performance
  - A-Port (Host Side)
    - 2000-V Human-Body Model
    - 1000-V Charged-Device Model
  - B-Port (Peripheral Side)
    - 8000-V Contact Discharge
    - 15000-V Air-Gap Discharge

## **DESCRIPTION/ORDERING INFORMATION**

The SN74AVC2T872 is a 2-bit voltage level translator optimized for use in interchip USB (IC-USB) applications.  $V_{CCA}$  and  $V_{CCB}$  can each operate over the full range of 1.1 V to 3.6 V. The device has been designed to maintain crossover skew to be less than 1 ns. Each B-port has an integrated 120-k $\Omega$  pulldown resistor that can be enabled and disabled using the PD\_EN control signal. If  $V_{CCB} = 0$  V, the A-port I/Os are disabled (Hi-Z) and the B-port I/Os are held to GND through the 120-k $\Omega$  resistors. If  $V_{CCA} = 0$  V, the A-port and B-port I/Os are disabled (Hi-Z).

#### **ORDERING INFORMATION**

T <sub>A</sub>	PACKA	GE <sup>(1)(2)</sup>	ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>			
-40°C to 85°C	WCSP – YFP	Reel of 3000	SN74AVC2T872YFPR	TU _			

For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI
web site at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

(3) YFP: The actual top-side marking has three preceding characters to denote year, month, and sequence code, and one following character to designate the assembly/test site. Pin 1 identifier indicates solder-bump composition (1 = SnPb, • = Pb-free).



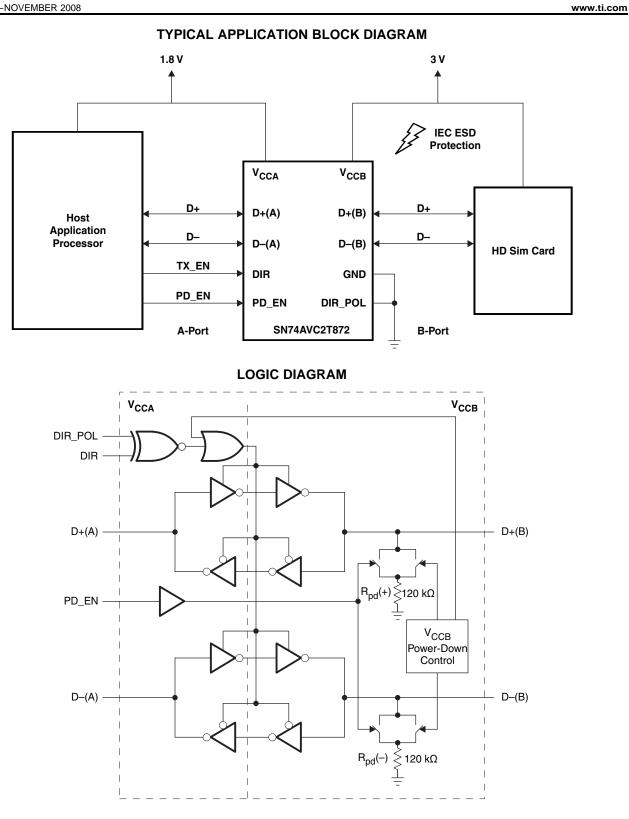
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

YFP PACKAGE (TOP VIEW)											
	1	2	3	_							
А	0	$\bigcirc$	$\bigcirc$								
В	$\odot$	$\bigcirc$	$\bigcirc$								
С	0	$\bigcirc$	$\bigcirc$								
D	0	$\bigcirc$	0								
				-							

	1	2	3
A	PD_EN	V <sub>CCA</sub>	V <sub>CCB</sub>
В	D+(A)	V <sub>CCA</sub>	D+(B)
С	D–(A)	GND	D–(B)
D	DIR	GND	DIR_POL

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#### **TERMINAL FUNCTIONS**

BALL NO.	NAME	FUNCTION
A1	PD_EN	Input to enable pulldown resistors on B-side. PD_EN = Low will disconnect the pulldown resistors. PD_EN = High will connect the pulldown resistors.
A2, B2	V <sub>CCA</sub>	A-side supply voltage (1.1 V to 3.6 V)
A3	V <sub>CCB</sub>	B-side supply voltage (1.1 V to 3.6 V)
B1	D+(A)	USB data signal connected to host.
B3	D+(B)	USB data signal connected to peripheral with internal 120 k $\Omega$ resistor to GND that can be disconnected by PD_EN.
C1	D–(A)	USB data signal connected to host.
C2, D2	GND	Ground
C3	D–(B)	USB data signal connected to peripheral with internal 120 k $\Omega$ resistor to GND that can be disconnected by PD_EN.
D1	DIR	Direction control input. If DIR_POL = Low, then DIR = Low allows A to B data flow. If DIR_POL = High, then DIR = High allows A to B data flow.
D3	DIR_POL	Direction polarity chooser. If DIR_POL = Low, then DIR = Low allows A to B data flow. If DIR_POL = High, then DIR = High allows A to B data flow.

### **FUNCTION TABLE**

INP	UTS	A-SIDE	B-SIDE	FUNCTION		
DIR_POL	DIR	A-SIDE	B-SIDE	FUNCTION		
L	L	Input	Output	A-to-B Data Flow		
L	Н	Output	Output Input B-to-A			
Н	L	Output	Input	B-to-A Data Flow		
Н	Н	Input	Output	A-to-B Data Flow		

### **B-SIDE PULLDOWN RESISTOR BEHAVIOR**

V	V		PULLDOWN RESISTOR
V <sub>CCA</sub>	V <sub>CCB</sub>	PD_EN	B-SIDE
0 V	Х	Х	None
1.1 to 3.6 V	0 V	Х	120 kΩ to GND
1.1 to 3.6 V	1.1 to 3.6 V	L	None
1.1 to 3.6 V	1.1 to 3.6 V	Н	120 kΩ to GND



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#### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

			MIN	MAX	UNIT
$V_{CCA}$ $V_{CCB}$	Supply voltage range		-0.5	4.6	V
		I/O ports (A-Port)	-0.5	4.6	
VI	Input voltage range <sup>(2)</sup>	I/O ports (B-Port)	-0.5	4.6	V
		Control inputs	-0.5	4.6	
V	Voltage range applied to any output in the high-impedance or	A-Port	-0.5	4.6	V
Vo	power-off state <sup>(2)</sup>	B-Port	-0.5	4.6	v
V	Voltage range applied to any output in the high or low state <sup>(2)</sup>	A-Port	-0.5	$V_{CCA} + 0.5$	V
Vo	voltage range applied to any output in the high of low state v	B-Port	-0.5	V	
I <sub>IK</sub>	Input clamp current	V <sub>1</sub> < 0		-50	mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0		-50	mA
I <sub>O</sub>	Continuous output current			±50	mA
	Continuous current through $V_{CCA}$ , $V_{CCB}$ , or GND			±100	mA
$\theta_{JA}$	Package thermal impedance <sup>(3)</sup>	YFP package		137.5	°C/W
T <sub>stg</sub>	Storage temperature range		-65	150	°C

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

(2)

(3) The package thermal impedance is calculated in accordance with JESD 51-7.



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## **RECOMMENDED OPERATING CONDITIONS**<sup>(1)(2)(3)</sup>

			V <sub>CCI</sub>	V <sub>cco</sub>	MIN	MAX	UNIT
V <sub>CCA</sub>	Supply voltage				1.1	3.6	V
V <sub>CCB</sub>	Supply voltage				1.1	3.6	V
			1.1 V to 1.95 V		$V_{CCI} \times 0.65$	V <sub>CCI</sub> × 0.65	
VIH	High-level input voltage	Data inputs <sup>(4)</sup>	1.95 V to 2.7 V		1.65		V
	input voltago		2.7 V to 3.6 V		2		
			1.1 V to 1.95 V			$V_{CCI} \times 0.35$	
VIL	Low-level input voltage	Data inputs <sup>(4)</sup>	1.95 V to 2.7 V			0.7	V
	input voltage		2.7 V to 3.6 V			0.8	
Lligh lovel			1.1 V to 1.95 V		$V_{CCA} \times 0.65$		
VIH	High-level input voltage	DIR, DIR_POL, PD_EN (referenced to V <sub>CCA</sub> ) <sup>(5)</sup>	1.95 V to 2.7 V		$V_{CCA} \times 0.65$		V
	input voltage		2.7 V to 3.6 V		$V_{CCA} \times 0.65$		
			1.1 V to 1.95 V			$V_{CCA} \times 0.35$	
VIL	Low-level input voltage	DIR, DIR_POL, PD_EN (referenced to V <sub>CCA</sub> ) <sup>(5)</sup>	1.95 V to 2.7 V			$V_{CCA} \times 0.35$	V
			2.7 V to 3.6 V			$V_{CCA} \times 0.35$	
VI	Input voltage				0	3.6	V
V	Output voltogo	Active state			0	V <sub>cco</sub>	V
Vo	Output voltage	3-state			0	3.6	V
				1.1 to 1.3 V		-2	
				1.4 V to 1.6 V		-6	
I <sub>OH</sub>	High-level output c	urrent		1.65 V to 1.95 V		-8	mA
				2.3 V to 2.7 V		-9	
				3 V to 3.6 V		-12	
				1.1 V to 1.3 V		2	
				1.4 V to 1.6 V		6	
I <sub>OL</sub>	Low-level output co	urrent		1.65 V to 1.95 V		8	mA
				2.3 V to 2.7 V		9	
				3 V to 3.6 V		12	
Δt/Δv	Input transition rise	e or fall rate				5	ns/V
T <sub>A</sub>	Operating free-air	temperature			-40	85	°C

(1)

(2)

 $V_{CCI}$  is the  $V_{CC}$  associated with the input port.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port. All unused data inputs of the device must be held at  $V_{CCI}$  or GND to ensure proper device operation. All unused control inputs of the device must be held at  $V_{CCA}$  or GND to ensure proper device operation. See the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004. For deta input you apply the data short  $V_{CC}$  with  $V_{CC}$ (3)

(4) For data input values not specified in the data sheet,  $V_{IH} min = V_{CCI} \times 0.7 \text{ V}$ ,  $V_{IL} max = V_{CCI} \times 0.3 \text{ V}$ . (5) For control input values not specified in the data sheet,  $V_{IH} min = V_{CCA} \times 0.7 \text{ V}$ ,  $V_{IL} max = V_{CCA} \times 0.3 \text{ V}$ .



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## ELECTRICAL CHARACTERISTICS<sup>(1)(2)</sup>

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

		TEST COND		v	v	TA	= 25°C	:	-40°C to 8	5°C	UNIT
PARAMETER		TEST CONL	UTION5	V <sub>CCA</sub>	V <sub>CCB</sub>	MIN	TYP	MAX	MIN	MAX	UNIT
		I <sub>OH</sub> = −100 μA		1.1 V to 3.6 V	1.1 V to 3.6 V				$V_{\rm CCO} - 0.2$		
		I <sub>OH</sub> = -2 mA		1.1 V	1.1 V				0.9		
V		I <sub>OH</sub> = -6 mA		1.4 V	1.4 V				1		V
V <sub>OH</sub>		I <sub>OH</sub> = -8 mA	$V_{I} = V_{IH}$	1.65 V	1.65 V				1.2		v
		I <sub>OH</sub> = -9 mA		2.3 V	2.3 V				1.75		
		I <sub>OH</sub> = -12 mA		3 V	3 V				2.3		
		I <sub>OL</sub> = 100 μA		1.1 V to 3.6 V	1.1 V to 3.6 V					0.2	
		I <sub>OL</sub> = 3 mA		1.1 V	1.1 V					0.3	
V		$I_{OL} = 6 \text{ mA}$	$V_{I} = V_{IL}$	1.4 V	1.4 V					0.35	V
V <sub>OL</sub>		$I_{OL} = 8 \text{ mA}$	$v_{I} = v_{IL}$	1.65 V	1.65 V					0.45	v
		I <sub>OL</sub> = 9 mA		2.3 V	2.3 V					0.55	
		I <sub>OL</sub> = 12 mA		3 V	3 V					0.7	
I <sub>I</sub>	Control inputs	$V_I = V_{CCA}$ or GND		1.1 V to 3.6 V	1.1 V to 3.6 V	±C	0.025	±0.25		±1	μA
I <sub>off</sub>	A port	$V_{I}$ or $V_{O} = 0$ to 3.6	V	0 V	0 V to 3.6 V	E	±0.02	±2.5		±5	μΑ
	A port	DIR_POL = Low,	DIR = Low	3.6 V	3.6 V	E	±0.01	±2.5		±5	_
I <sub>OZ</sub>	B port	$PD_EN = Low,$ $V_I = V_{CCI}$ to GND,	DIR = High	3.6 V	3.6 V	Ę	±0.14	±5		±15	μA
				1.1 V to 3.6 V	1.1 V to 3.6 V		0.02			10	
I <sub>CCA</sub>		$V_I = V_{CCI}$ or GND,	I <sub>O</sub> = 0	0 V	0 V to 3.6 V					-2	μA
				0 V to 3.6 V	0 V		0.01			10	
				1.1 V to 3.6 V	1.1 V to 3.6 V		0.13			30	
I <sub>CCB</sub>		$V_I = V_{CCI}$ or GND,	I <sub>O</sub> = 0	0 V	0 V to 3.6 V		0.07			15	μA
				0 V to 3.6 V	0 V					-2	
I <sub>CCA</sub> +	н I <sub>CCB</sub>	$V_I = V_{CCI}$ or GND,	I <sub>O</sub> = 0	1.1 V to 3.6 V	1.1 V to 3.6 V		0.15			40	μA
Ci	Control inputs	V <sub>1</sub> = 3.3 V or GND		3.6 V	3.6 V		1.5			2	pF
C: A port		$V_{\rm c} = 3.3 V_{\rm c}$ or CND		3.6 V	3.6 V		5.5			7	~E
Cia –	B port	$V_0 = 3.3 V \text{ or GND}$		3.0 V	3.0 V		27			32.5	pF
R <sub>pd(+)</sub> R <sub>pd(-)</sub>	,	DIR_POL = Low, DIR = High, PD_EN = High		3.6 V	3.6 V		118		80	150	kΩ

 $\begin{array}{ll} \mbox{(1)} & V_{CCO} \mbox{ is the } V_{CC} \mbox{ associated with the output port.} \\ \mbox{(2)} & V_{CCI} \mbox{ is the } V_{CC} \mbox{ associated with the input port.} \end{array}$ 



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### SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $V_{CCA} = 1.2 \text{ V} \pm 0.1 \text{ V}$ , PD\_EN = 0 V (unless otherwise noted)

PA	ARAMETER	FROM TO		V <sub>CCB</sub> = 1.2 V ± 0.1 V	V <sub>CCB</sub> = 1.5 V ± 0.1 V	V <sub>CCB</sub> = 1.8 V ± 0.15 V	V <sub>CCB</sub> = 2.5 V ± 0.2 V	V <sub>CCB</sub> = 3.3 V ± 0.3 V	UNIT	
		(INPUT)	(OUTPUT)	MIN MAX MIN MAX MIN MA		MIN MAX	MIN MAX	MIN MAX		
t <sub>PLH</sub>		D+(A) to	D+(A) to $D+(B)$ or		16	14	12	11	ns	
t <sub>PHL</sub>	Propagation	D–(A) to	0 D(B)	22	16	14	12	11	115	
t <sub>PLH</sub>	delay	D+(B) to	D+(A) or	19	17	17	16	15		
t <sub>PHL</sub>		D–(B) to	D–(A)	19	17	17	16	15	ns	
tr	Output rise time			14 14		14	14	14	ns	
t <sub>f</sub>	Output fall time			14 14		14	14	14	ns	
t <sub>PHZ</sub>		DIR or DIR_POL	POL D+(A) or D–(A)	24	24	24	24	24	ns	
t <sub>PLZ</sub>	Disable time	DIR OF DIR_FOL		24	24	24 24 24		24	115	
t <sub>PHZ</sub>	Disable time	DIR or DIR POL	D+(B) or D–(B)	28	22	19	15	14	ns	
t <sub>PLZ</sub>		DIR OF DIR_FOL	D+(B) 01 D-(B)	28	22	19	15	14	115	
t <sub>PZH</sub>		DIR or DIR POL	D+(A) or D–(A)	47	39	36	31	29	ns	
t <sub>PZL</sub>	Enable time <sup>(1)</sup>	DIR OF DIR_FOL	D+(A) 01 D-(A)	47	39	36	31	29	115	
t <sub>PZH</sub>		DIR or DIR_POL		D+(B) or D–(B)	46	40	38	36	35	ns
t <sub>PZL</sub>			D+(B) 01 D-(B)	46	40	38	36	35	115	
F <sub>max</sub>	Max data rate			12	12	12	12	12	Mbps	

(1) The enable time is a calculated value derived using the formula shown in the enable times section.



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### SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $V_{CCA} = 1.5 \text{ V} \pm 0.1 \text{ V}$ , PD\_EN = 0 V (unless otherwise noted)

PA	ARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.7		V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.2		V <sub>CCB</sub> = ± 0.3		UNIT	
		(INFOT)	(001-01)	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
t <sub>PLH</sub>		D+(A) to	D+(B) or		18	0.7	13.3	0.5	11.3	0.4	8.9	0.3	7.7		
t <sub>PH</sub>	Propagation	D–(A) to	) D–(B)		18	0.7	11.8	0.5	10.2	0.4	8.2	0.3	7.5	ns	
t <sub>PLH</sub>	delay	D+(B) to	D+(A) or		13	0.8	11.2	0.7	10.5	0.6	9.7	0.5	9.3	ns	
t <sub>PHL</sub>		D–(B) to	) D–(A)		13	0.8	10.9	0.7	10.2	0.6	9.4	0.5	9.1	115	
tr	Output rise time				14		10		10		10		10	ns	
t <sub>f</sub>	Output fall time				14		10		10		10		10	ns	
t <sub>PHZ</sub>		DIR or DIR POL	D+(A) or D–(A)		17	1.3	14.2	1.3	13.4	1	11.8	1	11.1	ns	
t <sub>PLZ</sub>	Disable time	DIR OF DIR_FOL			17	1.3	14.2	1.3	14.3	1	14.4	1	14.4	115	
t <sub>PHZ</sub>	Disable time	DIR or DIR POL	D+(B) or D–(B)		22	1.1	14.5	1.4	13.3	1.2	10.6	1.7	10.1	ns	
t <sub>PLZ</sub>		DIR OF DIR_FOL	D+(B) 01 D-(B)		22	1.1	16.8	1.4	13.5	1.2	9.8	1.7	9.3	115	
t <sub>PZH</sub>			D+(A) or D–(A)		35		28		24		19.5		18.5	ns	
t <sub>PZL</sub>	Enable time <sup>(1)</sup>	DIR or DIR_POL	D+(A) 01 D-(A)		35		25.3		23.5		20		19.2	115	
t <sub>PZH</sub>					35		27.5		25.5		23.2		22.1	20	
t <sub>PZL</sub>			. D+(B) or D–(B)		35		26.1		23.6		20		18.6	ns	
F <sub>max</sub>	Max data rate			12		12		12		12		12		Mbps	

(1) The enable time is a calculated value derived using the formula shown in the enable times section.



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### SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$ , PD\_EN = 0 V (unless otherwise noted)

			•	•	. 00/1					•						
P/	ARAMETER	FROM TO (INPUT) (OUTPUT)		V <sub>CCB</sub> = 7 ± 0.1		V <sub>CCB</sub> = ± 0.7		V <sub>CCB</sub> = ± 0.15		V <sub>CCB</sub> = ± 0.2		V <sub>ССВ</sub> = ± 0.3		UNIT		
		(INPUT)	(001901)	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX			
t <sub>PLH</sub>		D+(A) to D+(B) or			17	0.7	12.6	0.4	10.5	0.2	8.1	0.2	6.9			
t <sub>PHL</sub>	Propagation	D–(A) t	o D–(B)		17	0.7	11.2	0.4	9.5	0.2	7.4	0.2	6.7	ns		
t <sub>PLH</sub>	delay	D+(B) to	D+(A) or		11	0.5	9.5	0.4	8.8	0.5	7.9	0.4	7.5			
t <sub>PHL</sub>		D–(B) t	o D–(A)		11	0.5	9.3	0.4	8.7	0.5	7.9	0.4	7.6	ns		
tr	Output rise time				14		10		10		10		10	ns		
t <sub>f</sub>	Output fall time				14		10		10		10		10	ns		
t <sub>PHZ</sub>		DIR or	DIR or	DIR or	$D_{1}(A) \approx D_{1}(A)$		13	1.1	11.4	1	10.8	0.5	9.8	0.5	9	ns
t <sub>PLZ</sub>	Dischla time	DIR_POL	D+(A) or D–(A)		13	1.1	10.7	1	10.8	0.5	10.8	0.5	10.9	115		
t <sub>PHZ</sub>	Disable time	DIR or			21	1.1	10.7	1.3	10.6	0.8	9	0.5	9			
t <sub>PLZ</sub>		DIR_POL	D+(B) or D–(B)		21	1.1	15.7	1.3	12.5	0.8	8.8	0.5	8.3	ns		
t <sub>PZH</sub>		DIR or	D+(A) or D–(A)		32		25.2		21.3		16.7		15.8	ns		
t <sub>PZL</sub>	Enable Time <sup>(1)</sup>	DIR_POL	D+(A) 01 D-(A)		32		20.1		19.2		16.9		16.6	115		
t <sub>PZH</sub>		DIR or DIR_POL	D+(B) or D-(B)		30		23.3		21.3		18.9		17.7	20		
t <sub>PZL</sub>				D+(B) 01 D-(B)		30		22.7		20.3		17.2		15.8	ns	
$F_{max}$	Max data rate			12		12		12		12		12		Mbps		

(1) The enable time is a calculated value derived using the formula shown in the enable times section.



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### SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$ , PD\_EN = 0 V (unless otherwise noted)

Р	ARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.1		V <sub>ССВ</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.		V <sub>CCB</sub> = 3 ± 0.3		UNIT	
		(INPUT)	(001901)	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
t <sub>PLH</sub>		D+(A) to	D+(B) or		16	0.5	11.7	0.2	9.7	0.2	7.2	0.2	6		
t <sub>PHL</sub>	Propagation	D-(A) 1	to D–(B)		16	0.5	10.5	0.2	8.7	0.2	7.2	0.2	5.8	ns	
t <sub>PLH</sub>	delay	D+(B) to	D+(A) or		9	0.4	7.5	0.5	6.8	0.4	5.9	0.3	5.6	20	
t <sub>PHL</sub>		D–(B) t	to D–(A)		9	0.4	7.5	0.5	6.8	0.4	0.4 6 0.3	5.6	ns		
tr	Output rise time				14		10		10		10		10	ns	
t <sub>f</sub>	Output fall time				14		10		10		10		10	ns	
t <sub>PHZ</sub>		DIR or			11	0.7	7.8	0.7	7.5	0.7	6.9	0.5	6.4	ns	
t <sub>PLZ</sub>	Disable time	DIR_POL	D+(A) or D–(A)		11	0.7	6.8	0.7	6.8	0.7	6.8	0.5	6.8	115	
t <sub>PHZ</sub>	Disable lime	DIR or	D+(B) or D–(B)		19	0.6	8.4	0.5	7.4	0.5	6.3	1	7.2	20	
t <sub>PLZ</sub>		DIR_POL	D+(B) 01 D-(B)		19	0.6	14.4	0.5	11	0.5	7.4	1	6.9	ns	
t <sub>PZH</sub>		DIR or	D+(A) or D–(A)		29		21.9		17.8		13.3		12.5	ns	
t <sub>PZL</sub>	Enable time <sup>(1)</sup>	DIR_POL	D+(A) of $D-(A)$		29		15.9		14.2		12.2		12.8	115	
t <sub>PZH</sub>		DIR or DIR_POL	$D_{1}(P) \text{ or } D_{2}(P)$		27		18.5		16.4		14		12.8	20	
t <sub>PZL</sub>			D+(B) or D–(B)		27		18.2		16.2		14.1		12.2	ns	
F <sub>max</sub>	Max data rate			12		12		12		12		12		Mbps	

(1) The enable time is a calculated value derived using the formula shown in the enable times section.



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### SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $V_{CCA} = 3.3 \text{ V} \pm 0.3 \text{ V}$ , PD\_EN = 0 V (unless otherwise noted)

РА	RAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = <sup>-</sup> ± 0.1		V <sub>ССВ</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.2		V <sub>CCB</sub> = ± 0.3		UNIT	
		(INPOT)			MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
t <sub>PLH</sub>		D+(A) to	D+(B)		15	0.6	11.3	0.4	9.2	0.3	6.8	0.3	5.6	ns	
t <sub>PHL</sub>	Propagation	or D–(A) t	to D–(B)		15	0.6	10.2	0.4	8.4	0.3	6.2	0.3	5.5		
t <sub>PLH</sub>	delay	D+(B) to	D+(A)		9	0.3	6.6	0.2	5.8	0.2	4.9	0.2	4.5	ns	
t <sub>PHL</sub>		or D–(B) t	to D–(A)		9	0.3	7	0.2	6.2	0.2	5.3	0.2	4.9	115	
t <sub>r</sub>	Output rise time				14		10		10		10		10	ns	
t <sub>f</sub>	Output fall time				14		10		10		10		10	ns	
t <sub>PHZ</sub>			D+(A) or D–(A)		9	1	6.6	1	6.5	1	6.1	1	5.8	ns	
t <sub>PLZ</sub>	Disable time	DIR or DIR_POL			9	1	5.7	1	5.7	1	5.7	1	5.7		
t <sub>PHZ</sub>	Disable line	DIR or DIR_POL	D+(B) or D–(B)		19	0.5	7.4	0.3	6.5	0.3	5.2	0.3	5.3	ns	
t <sub>PLZ</sub>		DIR OF DIR_FOL	D+(B) 01 D-(B)		19	0.5	13.8	0.3	10.6	0.3	7	0.3	6.4		
t <sub>PZH</sub>		DIR or DIR POL	$D_{1}(\Lambda) \text{ or } D_{2}(\Lambda)$		28		20.4		16.4		11.9		10.9	20	
t <sub>PZL</sub>	Enable time <sup>(1)</sup>	DIR OF DIR_POL	D+(A) or D–(A)		28		14.4		12.7		10.4		10.2	ns	
t <sub>PZH</sub>			D+(B) or D-(B)		24		17		14.9		12.5		11.3	ns	
t <sub>PZL</sub>		DIR or DIR_POL			24		16.7		14.9		12.3		11.3		
F <sub>max</sub>	Max data rate			12		12		12		12		12		Mbps	

(1) The enable time is a calculated value derived using the formula shown in the enable times section.



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## **IC-USB INTERFACE CHARACTERISTICS**

over recommended operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$ , PD\_EN = 0 V (unless otherwise noted)

PARAMETER		FROM	TO (OUTPUT)	V <sub>CCB</sub> = 1. ± 0.15		V <sub>CCB</sub> = 3 ± 0.3 \	UNIT		
		(INPUT)	(001P01)	MIN	MAX	MIN	MAX		
	Output and a start	D+(A) to D–(A)	One seite Terreitiens	1		1			
t <sub>sko</sub>	Output crossover skew	D+(B) to D-(B)	Opposite Transitions		1		1	ns	
t <sub>jitter_c</sub>	Consecutive transitions jitter				2		2	ns	
t <sub>jitter_p</sub>	Paired transitions jitter				1		1		
F <sub>max</sub>	Max data rate			12		12		Mbps	

## **OPERATING CHARACTERISTICS**

 $T_A = 25^{\circ}C$ 

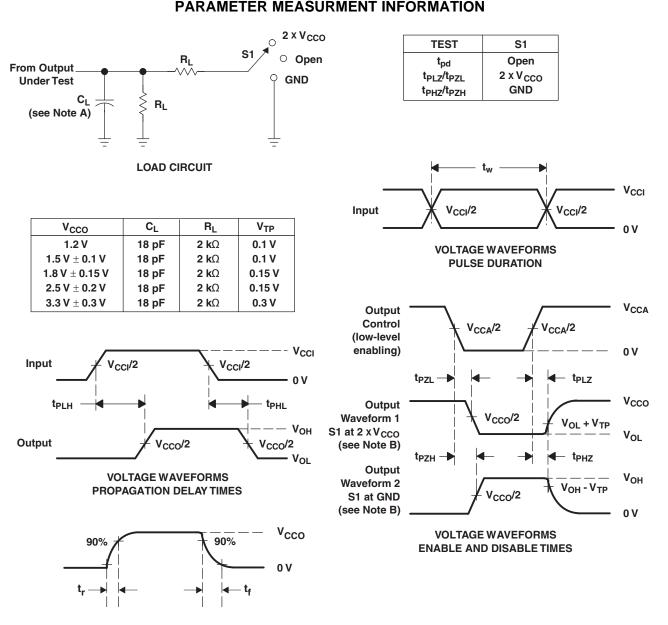
PAR	AMETER	TEST CONDITIONS	V <sub>CCA</sub> = V <sub>CCB</sub> = 1.2 V	V <sub>CCA</sub> = V <sub>CCB</sub> = 1.5 V	V <sub>CCA</sub> = V <sub>CCB</sub> = 1.8 V	V <sub>CCA</sub> = V <sub>CCB</sub> = 2.5 V	V <sub>CCA</sub> = V <sub>CCB</sub> = 3.3 V	UNIT	
		CONDITIONO	TYP	TYP	TYP	TYP	TYP		
C <sub>pdA</sub> <sup>(1)</sup>	A-port input, B-port output	C <sub>L</sub> = 0, f = 10 MHz,	1	1	1	1	2	pF	
CpdA	B-port input, A-port output	$t_{r} = t_{f} = 1 \text{ ns}$	14	14	14	16	20	р	
C <sub>pdB</sub> <sup>(1)</sup>	A-port input, B-port output	C <sub>L</sub> = 0, f = 10 MHz,	28	27	27	27	27	۶E	
⊂pdB`´	B-port input, A-port output	$t_r = t_f = 1 \text{ ns}$	1	1	1	1	2	рF	

(1) Power dissipation capacitance per transceiver



## SN74AVC2T872

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#### **OUTPUT RISE AND FALL TIMES**

- A. C<sub>L</sub> 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  $\leq$  10 MHz, Z<sub>0</sub> = 50 W, dv/dt  $\geq$  1 V/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  $t_{en}$ . For the SN74AVC2T872, these delays are calculated per the Enable Times forumulas shown in Table 1.
- 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.

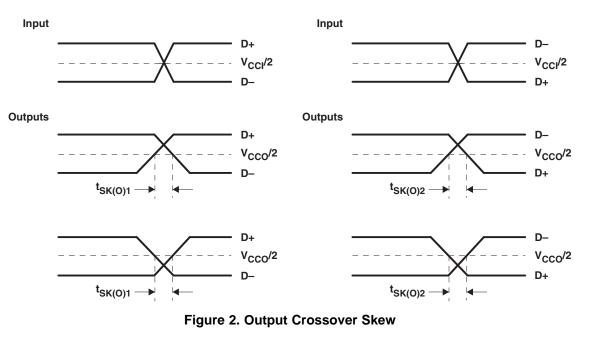
#### Figure 1. Load Circuit and Voltage Waveforms



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## PARAMETER MEASURMENT INFORMATION (continued)



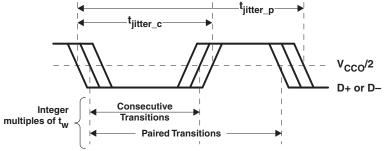


Figure 3. Output Jitter



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## **APPLICATION INFORMATION**

### **Enable Times**

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Calculate the enable times for the SN74AVC2T872 using the following formulas shown in Table 1.

$t_{PZH}$ (DIR to A) = $t_{PIZ}$ (DIR to B) + $t_{PIH}$ (B to A)	
$t_{PZL} (DIR to A) = t_{PHZ} (DIR to B) + t_{PHL} (B to A)$	
$t_{PZH} (DIR to B) = t_{PLZ} (DIR to A) + t_{PLH} (A to B)$	
$t_{PZL}$ (DIR to B) = $t_{PHZ}$ (DIR to A) + $t_{PHL}$ (A to B)	

In a bidirectional application, these enable times provide the maximum delay from the time the DIR bit is switched until an output is expected. For example, if the SN74AVC2T872 initially is transmitting from A to B, then the DIR bit is switched; the B port of the device must be disabled before presenting it with an input. After the B port has been disabled, an input signal applied to it appears on the corresponding A port after the specified propagation delay.

#### Table 1. Enable Times

### PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
SN74AVC2T872YFPR	ACTIVE	DSBGA	YFP	12	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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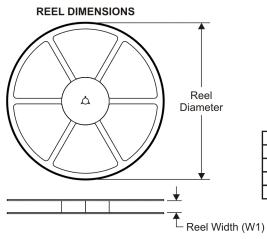
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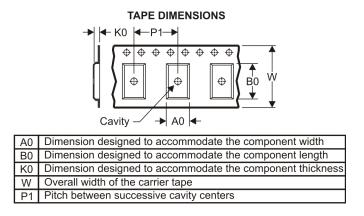
# PACKAGE MATERIALS INFORMATION

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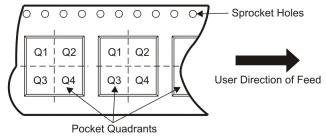
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### TAPE AND REEL INFORMATION





## QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal												
Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AVC2T872YFPR	DSBGA	YFP	12	3000	180.0	8.4	1.28	1.68	0.62	4.0	8.0	Q1

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# PACKAGE MATERIALS INFORMATION

27-Nov-2010



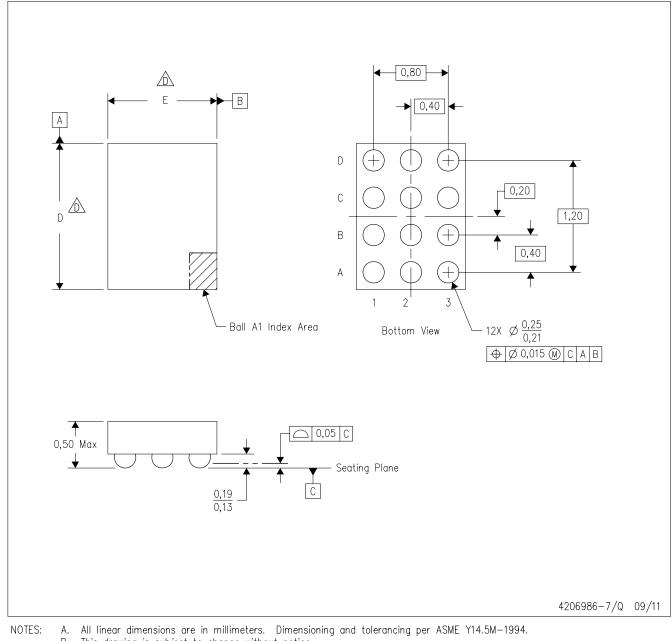
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVC2T872YFPR	DSBGA	YFP	12	3000	220.0	220.0	34.0

## **MECHANICAL DATA**

YFP (R-XBGA-N12)

DIE-SIZE BALL GRID ARRAY



- B. This drawing is subject to change without notice.
- C. NanoFree™ package configuration.
- (D) The package size (Dimension D and E) of a particular device is specified in the device Product Data Sheet version of this drawing, in case it cannot be found in the product data sheet please contact a local TI representative.
- E. Reference Product Data Sheet for array population.  $3 \times 4$  matrix pattern is shown for illustration only.
- F. This package contains Pb-free balls.

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