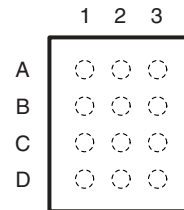


## VOLTAGE-LEVEL SHIFTER FOR IC-USB INTERFACE

### FEATURES

- $V_{CCA}$ ,  $V_{CCB}$  Supply Voltage: 1.1 V to 3.6 V
- When  $V_{CCB} = 0$  V, A-Port is Disabled and B-Port is Held at GND Through 120-k $\Omega$  Pulldown
- Crossover Skew of <1 ns
- Meets All Requirements of the IC-USB Standard
- Small Package: 0.4 mm pitch WCSP (1.2 mm  $\times$  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

**YFP PACKAGE  
(TOP VIEW)**


	1	2	3
A	PD_EN	$V_{CCA}$	$V_{CCB}$
B	D+(A)	$V_{CCA}$	D+(B)
C	D-(A)	GND	D-(B)
D	DIR	GND	DIR_POL

### 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

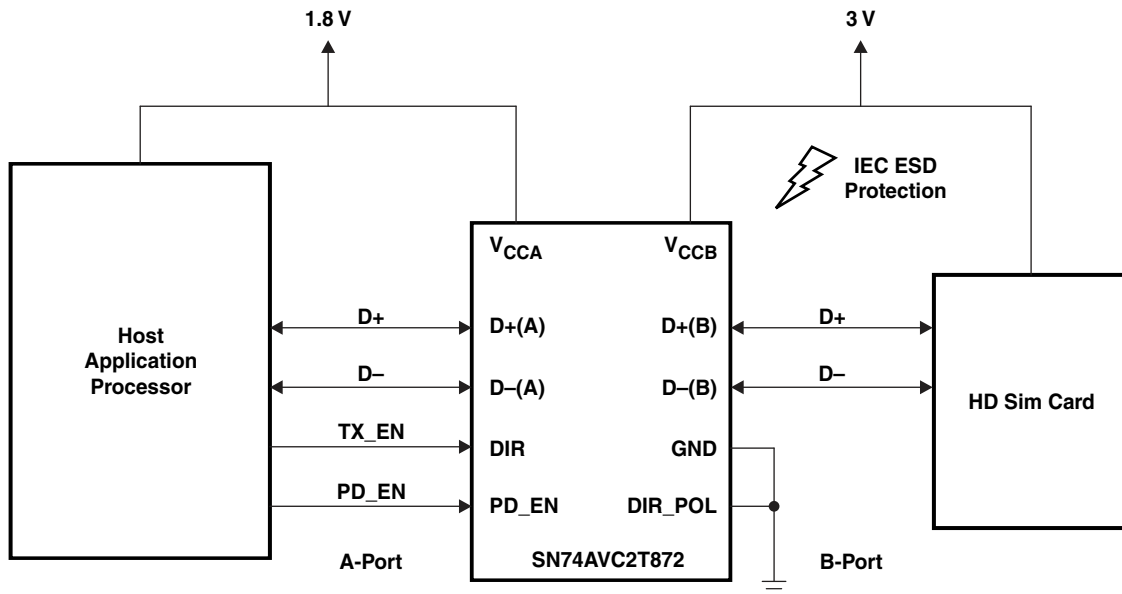
$T_A$	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>
–40°C to 85°C	WCSP – YFP	Reel of 3000	SN74AVC2T872YFPR	___ TU _

- (1) 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](http://www.ti.com).
- (2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://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).

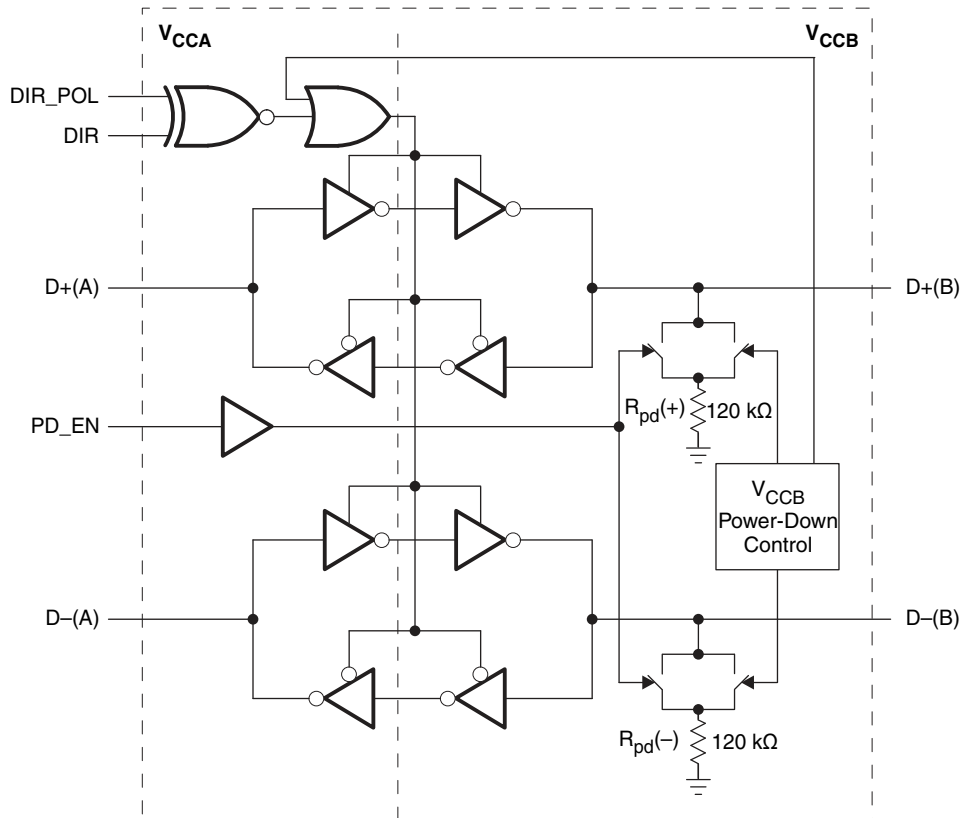


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

TYPICAL APPLICATION BLOCK DIAGRAM



LOGIC DIAGRAM



**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 kΩ 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 kΩ 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**

INPUTS		A-SIDE	B-SIDE	FUNCTION
DIR_POL	DIR			
L	L	Input	Output	A-to-B Data Flow
L	H	Output	Input	B-to-A Data Flow
H	L	Output	Input	B-to-A Data Flow
H	H	Input	Output	A-to-B Data Flow

**B-SIDE PULLDOWN RESISTOR BEHAVIOR**

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

**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		
$V_I$	Input voltage range <sup>(2)</sup>	I/O ports (A-Port)	-0.5	4.6	V	
		I/O ports (B-Port)	-0.5	4.6		
		Control inputs	-0.5	4.6		
$V_O$	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A-Port	-0.5	4.6	V	
		B-Port	-0.5	4.6		
$V_O$	Voltage range applied to any output in the high or low state <sup>(2)</sup>	A-Port	-0.5	$V_{CCA} + 0.5$	V	
		B-Port	-0.5	$V_{CCB} + 0.5$		
$I_{IK}$	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	
$\theta_{JA}$	Package thermal impedance <sup>(3)</sup>	YFP package		137.5	°C/W	
$T_{stg}$	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.
- (2) The input voltage and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

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

		$V_{CCI}$	$V_{CCO}$	MIN	MAX	UNIT
$V_{CCA}$	Supply voltage			1.1	3.6	V
$V_{CCB}$	Supply voltage			1.1	3.6	V
$V_{IH}$	High-level input voltage	Data inputs <sup>(4)</sup>	1.1 V to 1.95 V	$V_{CCI} \times 0.65$		V
			1.95 V to 2.7 V	1.65		
			2.7 V to 3.6 V	2		
$V_{IL}$	Low-level input voltage	Data inputs <sup>(4)</sup>	1.1 V to 1.95 V	$V_{CCI} \times 0.35$		V
			1.95 V to 2.7 V	0.7		
			2.7 V to 3.6 V	0.8		
$V_{IH}$	High-level input voltage	DIR, DIR_POL, PD_EN (referenced to $V_{CCA}$ ) <sup>(5)</sup>	1.1 V to 1.95 V	$V_{CCA} \times 0.65$		V
			1.95 V to 2.7 V	$V_{CCA} \times 0.65$		
			2.7 V to 3.6 V	$V_{CCA} \times 0.65$		
$V_{IL}$	Low-level input voltage	DIR, DIR_POL, PD_EN (referenced to $V_{CCA}$ ) <sup>(5)</sup>	1.1 V to 1.95 V	$V_{CCA} \times 0.35$		V
			1.95 V to 2.7 V	$V_{CCA} \times 0.35$		
			2.7 V to 3.6 V	$V_{CCA} \times 0.35$		
$V_I$	Input voltage			0	3.6	V
$V_O$	Output voltage	Active state		0	$V_{CCO}$	V
		3-state		0	3.6	
$I_{OH}$	High-level output current		1.1 to 1.3 V	–2		mA
			1.4 V to 1.6 V	–6		
			1.65 V to 1.95 V	–8		
			2.3 V to 2.7 V	–9		
			3 V to 3.6 V	–12		
$I_{OL}$	Low-level output current		1.1 V to 1.3 V	2		mA
			1.4 V to 1.6 V	6		
			1.65 V to 1.95 V	8		
			2.3 V to 2.7 V	9		
			3 V to 3.6 V	12		
$\Delta t/\Delta v$	Input transition rise or fall rate				5	ns/V
$T_A$	Operating free-air temperature			–40	85	°C

- (1)  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- (2)  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- (3) 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](#).
- (4) For data input values not specified in the data sheet,  $V_{IH} \text{ min} = V_{CCI} \times 0.7 \text{ V}$ ,  $V_{IL} \text{ max} = V_{CCI} \times 0.3 \text{ V}$ .
- (5) For control input values not specified in the data sheet,  $V_{IH} \text{ min} = V_{CCA} \times 0.7 \text{ V}$ ,  $V_{IL} \text{ max} = V_{CCA} \times 0.3 \text{ V}$ .

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

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	TYP	MAX	MIN	MAX	
V <sub>OH</sub>	I <sub>OH</sub> = –100 μA		1.1 V to 3.6 V	1.1 V to 3.6 V				V <sub>CCO</sub> – 0.2		V
	I <sub>OH</sub> = –2 mA		1.1 V	1.1 V				0.9		
	I <sub>OH</sub> = –6 mA		1.4 V	1.4 V				1		
	I <sub>OH</sub> = –8 mA		1.65 V	1.65 V				1.2		
	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		
V <sub>OL</sub>	I <sub>OL</sub> = 100 μA		1.1 V to 3.6 V	1.1 V to 3.6 V				0.2		V
	I <sub>OL</sub> = 3 mA		1.1 V	1.1 V				0.3		
	I <sub>OL</sub> = 6 mA		1.4 V	1.4 V				0.35		
	I <sub>OL</sub> = 8 mA		1.65 V	1.65 V				0.45		
	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 <sub>I</sub> = V <sub>CCA</sub> or GND	1.1 V to 3.6 V	1.1 V to 3.6 V	±0.025	±0.25		±1	μA	
I <sub>off</sub>	A port	V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V	0 V	0 V to 3.6 V	±0.02	±2.5		±5	μA	
I <sub>OZ</sub>	A port	DIR_POL = Low, PD_EN = Low, V <sub>I</sub> = V <sub>CCI</sub> to GND,	DIR = Low	3.6 V	3.6 V	±0.01	±2.5		±5	μA
	B port		DIR = High	3.6 V	3.6 V	±0.14	±5		±15	
I <sub>CCA</sub>	V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0		1.1 V to 3.6 V	1.1 V to 3.6 V	0.02			10	μA	
			0 V	0 V to 3.6 V				–2		
			0 V to 3.6 V	0 V	0.01			10		
I <sub>CCB</sub>	V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0		1.1 V to 3.6 V	1.1 V to 3.6 V	0.13			30	μA	
			0 V	0 V to 3.6 V	0.07			15		
			0 V to 3.6 V	0 V				–2		
I <sub>CCA</sub> + I <sub>CCB</sub>	V <sub>I</sub> = V <sub>CCI</sub> 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	
C <sub>i</sub>	Control inputs	V <sub>I</sub> = 3.3 V or GND	3.6 V	3.6 V	1.5			2	pF	
C <sub>io</sub>	A port	V <sub>O</sub> = 3.3 V or GND	3.6 V	3.6 V	5.5			7	pF	
	B port				27			32.5		
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	

(1) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port.(2) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port.

## SWITCHING CHARACTERISTICS

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

PARAMETER		FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{PLH}$	Propagation delay	D+(A) to D+(B) or D-(A) to D-(B)		22	16	14	12	11	ns					
$t_{PHL}$				22	16	14	12	11						
$t_{PLH}$		D+(B) to D+(A) or D-(B) to D-(A)		19	17	17	16	15	ns					
$t_{PHL}$				19	17	17	16	15						
$t_r$	Output rise time			14	14	14	14	14	ns					
$t_f$	Output fall time			14	14	14	14	14	ns					
$t_{PHZ}$	Disable time	DIR or DIR_POL	D+(A) or D-(A)	24	24	24	24	24	ns					
$t_{PLZ}$				24	24	24	24	24						
$t_{PHZ}$		DIR or DIR_POL	D+(B) or D-(B)	28	22	19	15	14	ns					
$t_{PLZ}$				28	22	19	15	14						
$t_{PZH}$	Enable time <sup>(1)</sup>	DIR or DIR_POL	D+(A) or D-(A)	47	39	36	31	29	ns					
$t_{PZL}$				47	39	36	31	29						
$t_{PZH}$		DIR or DIR_POL	D+(B) or D-(B)	46	40	38	36	35	ns					
$t_{PZL}$				46	40	38	36	35						
$F_{max}$	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.

## SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT	
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_{PLH}$	Propagation delay	D+(A) to D+(B) or D-(A) to D-(B)	18		0.7	13.3	0.5	11.3	0.4	8.9	0.3	7.7	ns	
$t_{PH}$			18		0.7	11.8	0.5	10.2	0.4	8.2	0.3	7.5		
$t_{PLH}$	Propagation delay	D+(B) to D+(A) or D-(B) to D-(A)	13		0.8	11.2	0.7	10.5	0.6	9.7	0.5	9.3	ns	
$t_{PHL}$			13		0.8	10.9	0.7	10.2	0.6	9.4	0.5	9.1		
$t_r$	Output rise time		14		10		10		10		10		ns	
$t_f$	Output fall time		14		10		10		10		10		ns	
$t_{PHZ}$	Disable time	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
$t_{PLZ}$				17		1.3	14.2	1.3	14.3	1	14.4	1	14.4	
$t_{PHZ}$		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
$t_{PLZ}$				22		1.1	16.8	1.4	13.5	1.2	9.8	1.7	9.3	
$t_{PZH}$	Enable time <sup>(1)</sup>	DIR or DIR_POL	D+(A) or D-(A)	35		28		24		19.5		18.5		ns
$t_{PZL}$				35		25.3		23.5		20		19.2		
$t_{PZH}$		DIR or DIR_POL	D+(B) or D-(B)	35		27.5		25.5		23.2		22.1		ns
$t_{PZL}$				35		26.1		23.6		20		18.6		
$F_{max}$	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.



## SWITCHING CHARACTERISTICS

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

PARAMETER		FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{PLH}$	Propagation delay	D+(A) to D+(B) or D-(A) to D-(B)		17		0.7	12.6	0.4	10.5	0.2	8.1	0.2	6.9	ns
$t_{PHL}$				17		0.7	11.2	0.4	9.5	0.2	7.4	0.2	6.7	
$t_{PLH}$		D+(B) to D+(A) or D-(B) to D-(A)		11		0.5	9.5	0.4	8.8	0.5	7.9	0.4	7.5	ns
$t_{PHL}$				11		0.5	9.3	0.4	8.7	0.5	7.9	0.4	7.6	
$t_r$	Output rise time			14		10		10		10		10		ns
$t_f$	Output fall time			14		10		10		10		10		ns
$t_{PHZ}$	Disable time	DIR or DIR_POL	D+(A) or D-(A)	13		1.1	11.4	1	10.8	0.5	9.8	0.5	9	ns
$t_{PLZ}$				13		1.1	10.7	1	10.8	0.5	10.8	0.5	10.9	
$t_{PHZ}$		DIR or DIR_POL	D+(B) or D-(B)	21		1.1	10.7	1.3	10.6	0.8	9	0.5	9	ns
$t_{PLZ}$				21		1.1	15.7	1.3	12.5	0.8	8.8	0.5	8.3	
$t_{PZH}$	Enable Time <sup>(1)</sup>	DIR or DIR_POL	D+(A) or D-(A)	32		25.2		21.3		16.7		15.8		ns
$t_{PZL}$				32		20.1		19.2		16.9		16.6		
$t_{PZH}$		DIR or DIR_POL	D+(B) or D-(B)	30		23.3		21.3		18.9		17.7		ns
$t_{PZL}$				30		22.7		20.3		17.2		15.8		
$F_{max}$	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.

## SWITCHING CHARACTERISTICS

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

PARAMETER		FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{PLH}$	Propagation delay	D+(A) to D+(B) or D-(A) to D-(B)		16		0.5	11.7	0.2	9.7	0.2	7.2	0.2	6	ns
$t_{PHL}$				16		0.5	10.5	0.2	8.7	0.2	7.2	0.2	5.8	
$t_{PLH}$		D+(B) to D+(A) or D-(B) to D-(A)		9		0.4	7.5	0.5	6.8	0.4	5.9	0.3	5.6	ns
$t_{PHL}$				9		0.4	7.5	0.5	6.8	0.4	6	0.3	5.6	
$t_r$	Output rise time			14		10		10		10		10		ns
$t_f$	Output fall time			14		10		10		10		10		ns
$t_{PHZ}$	Disable time	DIR or DIR_POL	D+(A) or D-(A)	11		0.7	7.8	0.7	7.5	0.7	6.9	0.5	6.4	ns
$t_{PLZ}$				11		0.7	6.8	0.7	6.8	0.7	6.8	0.5	6.8	
$t_{PHZ}$		DIR or DIR_POL	D+(B) or D-(B)	19		0.6	8.4	0.5	7.4	0.5	6.3	1	7.2	ns
$t_{PLZ}$				19		0.6	14.4	0.5	11	0.5	7.4	1	6.9	
$t_{PZH}$	Enable time <sup>(1)</sup>	DIR or DIR_POL	D+(A) or D-(A)	29		21.9		17.8		13.3		12.5		ns
$t_{PZL}$				29		15.9		14.2		12.2		12.8		
$t_{PZH}$		DIR or DIR_POL	D+(B) or D-(B)	27		18.5		16.4		14		12.8		ns
$t_{PZL}$				27		18.2		16.2		14.1		12.2		
$F_{max}$	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.

## SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT	
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_{PLH}$	Propagation delay	D+(A) to D+(B) or D-(A) to D-(B)	15		0.6	11.3	0.4	9.2	0.3	6.8	0.3	5.6	ns	
$t_{PHL}$			15		0.6	10.2	0.4	8.4	0.3	6.2	0.3	5.5		
$t_{PLH}$		D+(B) to D+(A) or D-(B) to D-(A)	9		0.3	6.6	0.2	5.8	0.2	4.9	0.2	4.5	ns	
$t_{PHL}$			9		0.3	7	0.2	6.2	0.2	5.3	0.2	4.9		
$t_r$	Output rise time		14		10		10		10		10		ns	
$t_f$	Output fall time		14		10		10		10		10		ns	
$t_{PHZ}$	Disable time	DIR or DIR_POL	D+(A) or D-(A)	9		1	6.6	1	6.5	1	6.1	1	5.8	ns
$t_{PLZ}$				9		1	5.7	1	5.7	1	5.7	1	5.7	
$t_{PHZ}$		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
$t_{PLZ}$				19		0.5	13.8	0.3	10.6	0.3	7	0.3	6.4	
$t_{PZH}$	Enable time <sup>(1)</sup>	DIR or DIR_POL	D+(A) or D-(A)	28		20.4		16.4		11.9		10.9		ns
$t_{PZL}$				28		14.4		12.7		10.4		10.2		
$t_{PZH}$		DIR or DIR_POL	D+(B) or D-(B)	24		17		14.9		12.5		11.3		ns
$t_{PZL}$				24		16.7		14.9		12.3		11.3		
$F_{max}$	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.

## IC-USB INTERFACE CHARACTERISTICS

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

PARAMETER		FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				MIN	MAX	MIN	MAX	
$t_{sko}$	Output crossover skew	D+(A) to D-(A)	Opposite Transitions		1		1	ns
		D+(B) to D-(B)		1		1		
$t_{jitter\_c}$	Consecutive transitions jitter			2			2	ns
$t_{jitter\_p}$	Paired transitions jitter			1			1	
$F_{max}$	Max data rate			12			12	Mbps

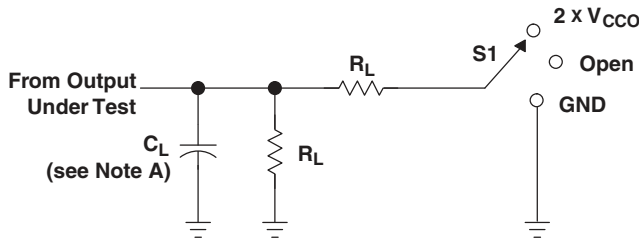
## OPERATING CHARACTERISTICS

$T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	$V_{CCA} =$ $V_{CCB} = 1.2 \text{ V}$	$V_{CCA} =$ $V_{CCB} = 1.5 \text{ V}$	$V_{CCA} =$ $V_{CCB} = 1.8 \text{ V}$	$V_{CCA} =$ $V_{CCB} = 2.5 \text{ V}$	$V_{CCA} =$ $V_{CCB} = 3.3 \text{ V}$	UNIT
			TYP	TYP	TYP	TYP	TYP	
$C_{pdA}^{(1)}$	A-port input, B-port output	$C_L = 0,$ $f = 10 \text{ MHz},$ $t_r = t_f = 1 \text{ ns}$	1	1	1	1	2	pF
	B-port input, A-port output		14	14	14	16	20	
$C_{pdB}^{(1)}$	A-port input, B-port output	$C_L = 0,$ $f = 10 \text{ MHz},$ $t_r = t_f = 1 \text{ ns}$	28	27	27	27	27	pF
	B-port input, A-port output		1	1	1	1	2	

(1) Power dissipation capacitance per transceiver

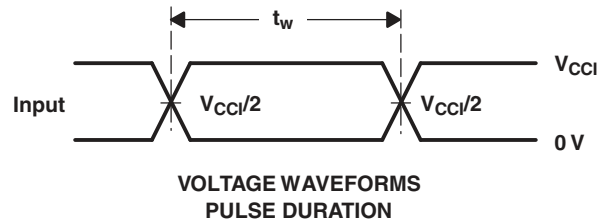
PARAMETER MEASUREMENT INFORMATION



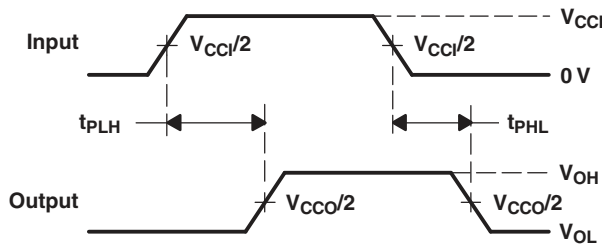
LOAD CIRCUIT

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

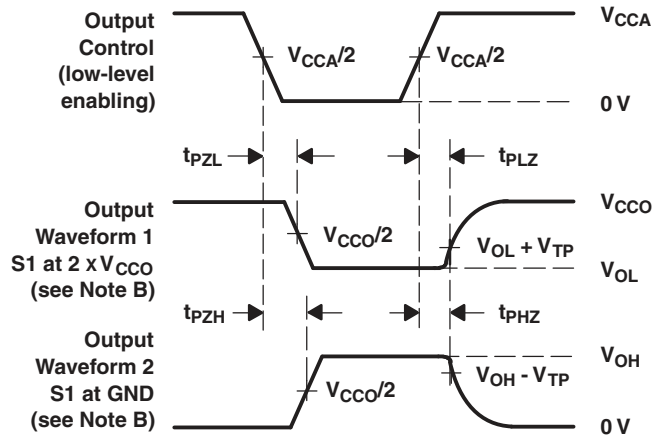
$V_{CCO}$	$C_L$	$R_L$	$V_{TP}$
1.2 V	18 pF	2 k $\Omega$	0.1 V
1.5 V $\pm$ 0.1 V	18 pF	2 k $\Omega$	0.1 V
1.8 V $\pm$ 0.15 V	18 pF	2 k $\Omega$	0.15 V
2.5 V $\pm$ 0.2 V	18 pF	2 k $\Omega$	0.15 V
3.3 V $\pm$ 0.3 V	18 pF	2 k $\Omega$	0.3 V



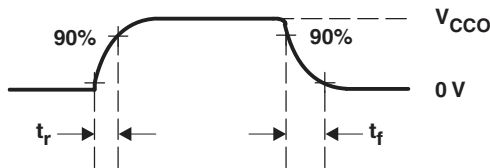
VOLTAGE WAVEFORMS PULSE DURATION



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES



OUTPUT RISE AND FALL TIMES

- 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:  $PRR \leq 10$  MHz,  $Z_O = 50$   $\Omega$ ,  $dv/dt \geq 1$  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 formulas 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

PARAMETER MEASUREMENT INFORMATION (continued)

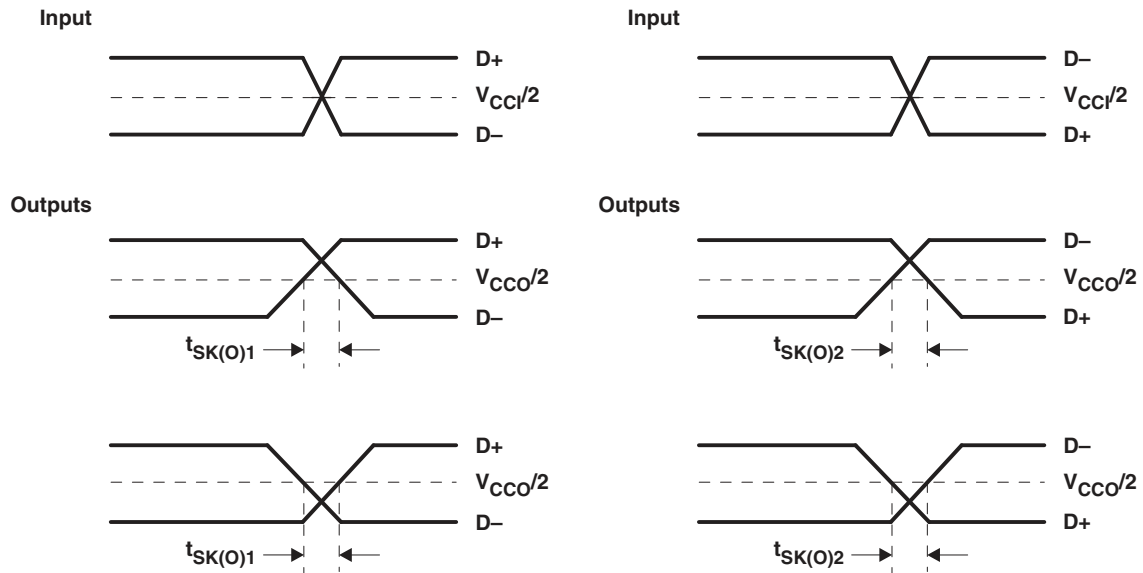


Figure 2. Output Crossover Skew

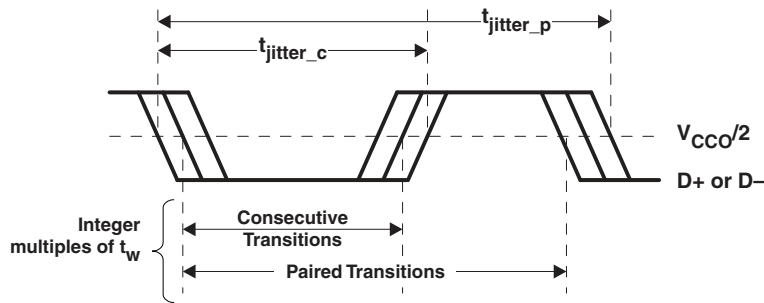


Figure 3. Output Jitter

## APPLICATION INFORMATION

### Enable Times

Calculate the enable times for the SN74AVC2T872 using the following formulas shown in [Table 1](#).

**Table 1. Enable Times**

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

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.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AVC2T872YFPR	NRND	DSBGA	YFP	12	3000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(TU2, TUN)	

(1) 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.

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

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL BOX DIMENSIONS

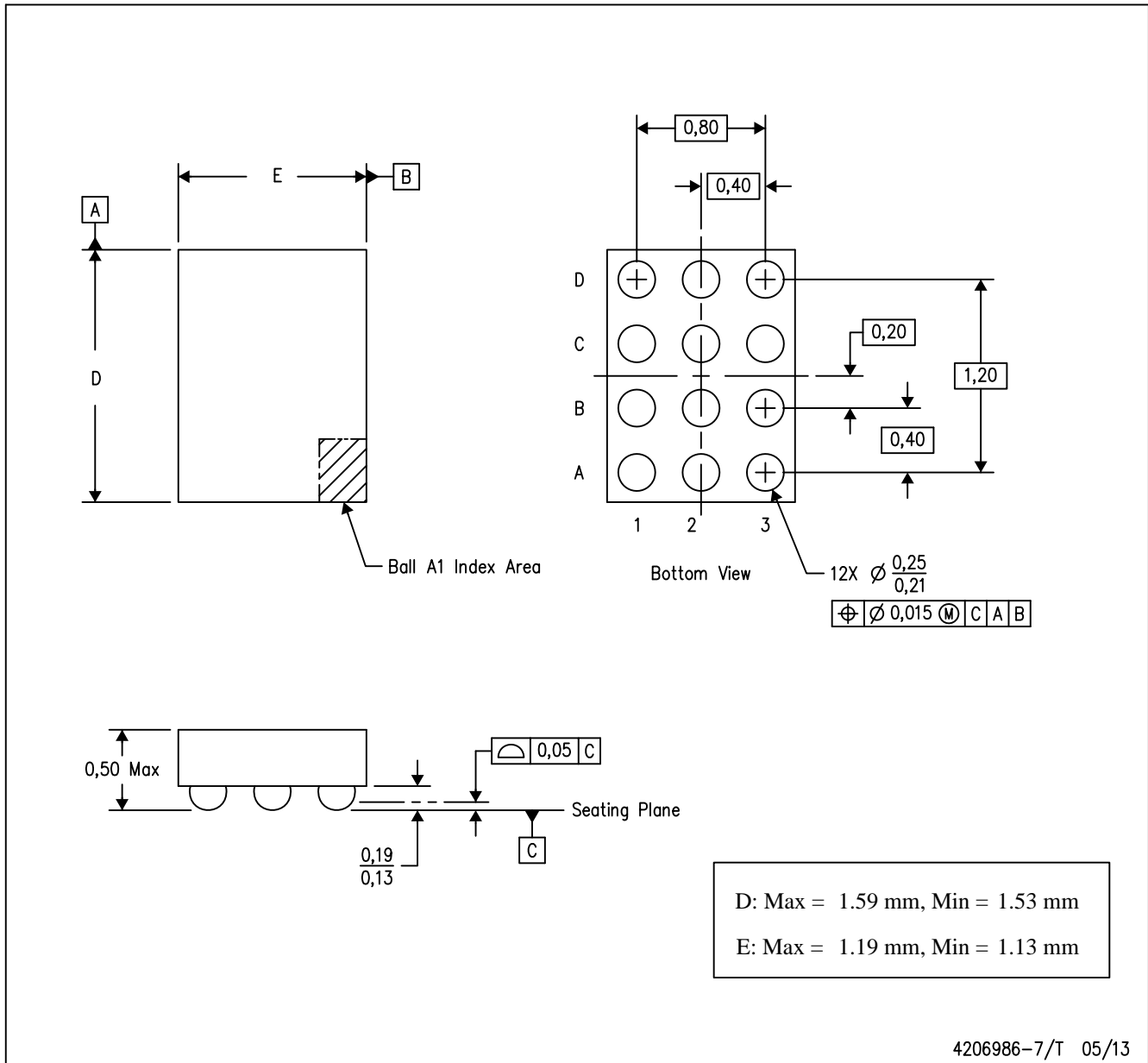


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVC2T872YFPR	DSBGA	YFP	12	3000	220.0	220.0	35.0

YFP (R-XBGA-N12)

DIE-SIZE BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. NanoFree™ package configuration.

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