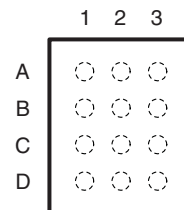


VOLTAGE-LEVEL SHIFTER FOR IC-USB INTERFACE

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 Ω 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 Ω 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 Ω resistors. If $V_{CCA} = 0$ V, the A-port and B-port I/Os are disabled (Hi-Z).

ORDERING INFORMATION

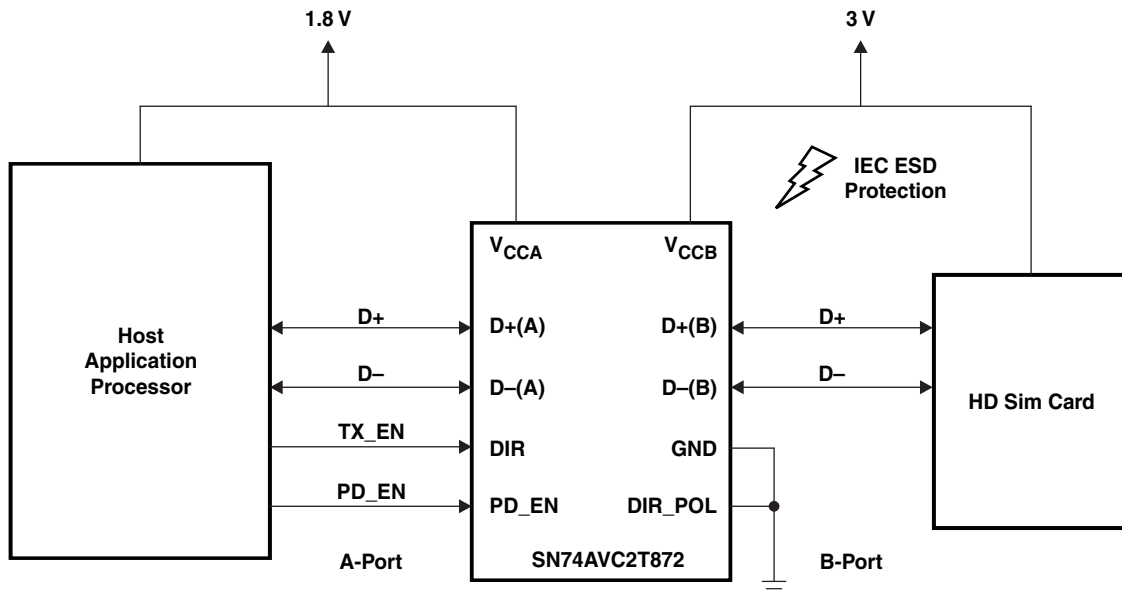
| T_A | PACKAGE ⁽¹⁾⁽²⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING ⁽³⁾ |
|---------------|---------------------------|--------------|-----------------------|---------------------------------|
| –40°C to 85°C | WCSP – YFP | Reel of 3000 | SN74AVC2T872YFPR | ___ TU _ |

- (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.
- (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).

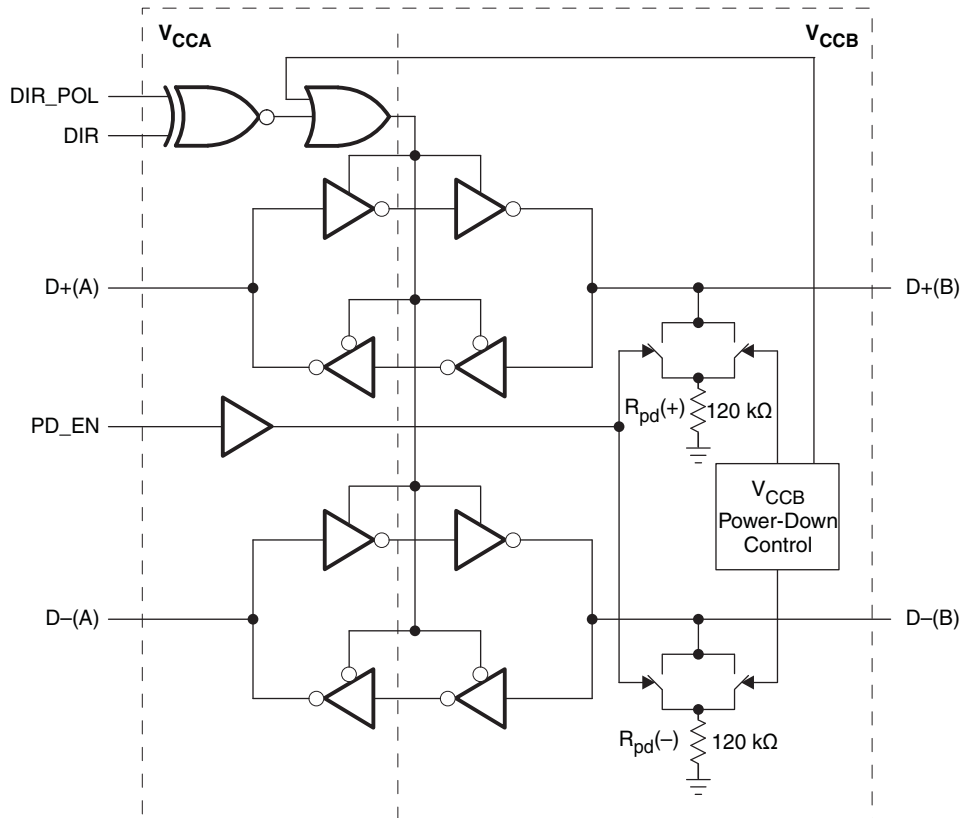


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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 _{CCA} | A-side supply voltage (1.1 V to 3.6 V) |
| A3 | V _{CCB} | 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 _{CCA} | V _{CCB} | 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⁽¹⁾

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 ⁽²⁾ | 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 ⁽²⁾ | 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 ⁽²⁾ | 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 | |
| θ_{JA} | Package thermal impedance ⁽³⁾ | 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⁽¹⁾⁽²⁾⁽³⁾

| | | 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 ⁽⁴⁾ | 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 ⁽⁴⁾ | 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}) ⁽⁵⁾ | 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}) ⁽⁵⁾ | 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⁽¹⁾⁽²⁾

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

| PARAMETER | TEST CONDITIONS | | V _{CCA} | V _{CCB} | T _A = 25°C | | | –40°C to 85°C | | UNIT |
|--|--|---|------------------|------------------|-----------------------|-------|------|------------------------|-----|------|
| | | | | | MIN | TYP | MAX | MIN | MAX | |
| V _{OH} | I _{OH} = –100 μA | | 1.1 V to 3.6 V | 1.1 V to 3.6 V | | | | V _{CCO} – 0.2 | | V |
| | I _{OH} = –2 mA | | 1.1 V | 1.1 V | | | | 0.9 | | |
| | I _{OH} = –6 mA | | 1.4 V | 1.4 V | | | | 1 | | |
| | I _{OH} = –8 mA | | 1.65 V | 1.65 V | | | | 1.2 | | |
| | I _{OH} = –9 mA | | 2.3 V | 2.3 V | | | | 1.75 | | |
| | I _{OH} = –12 mA | | 3 V | 3 V | | | | 2.3 | | |
| V _{OL} | I _{OL} = 100 μA | | 1.1 V to 3.6 V | 1.1 V to 3.6 V | | | | 0.2 | | V |
| | I _{OL} = 3 mA | | 1.1 V | 1.1 V | | | | 0.3 | | |
| | I _{OL} = 6 mA | | 1.4 V | 1.4 V | | | | 0.35 | | |
| | I _{OL} = 8 mA | | 1.65 V | 1.65 V | | | | 0.45 | | |
| | I _{OL} = 9 mA | | 2.3 V | 2.3 V | | | | 0.55 | | |
| | I _{OL} = 12 mA | | 3 V | 3 V | | | | 0.7 | | |
| I _i | Control inputs | V _I = V _{CCA} or GND | 1.1 V to 3.6 V | 1.1 V to 3.6 V | ±0.025 | ±0.25 | | ±1 | μA | |
| I _{off} | A port | V _I or V _O = 0 to 3.6 V | 0 V | 0 V to 3.6 V | ±0.02 | ±2.5 | | ±5 | μA | |
| I _{OZ} | A port | DIR_POL = Low, PD_EN = Low, V _I = V _{CCI} 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 _{CCA} | V _I = V _{CCI} or GND, I _O = 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 _{CCB} | V _I = V _{CCI} or GND, I _O = 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 _{CCA} + I _{CCB} | V _I = V _{CCI} or GND, I _O = 0 | | 1.1 V to 3.6 V | 1.1 V to 3.6 V | 0.15 | | | 40 | μA | |
| C _i | Control inputs | V _I = 3.3 V or GND | 3.6 V | 3.6 V | 1.5 | | | 2 | pF | |
| C _{io} | A port | V _O = 3.3 V or GND | 3.6 V | 3.6 V | 5.5 | | | 7 | pF | |
| | B port | | | | 27 | | | 32.5 | | |
| R _{pd(+)} , R _{pd(-)} | DIR_POL = Low, DIR = High, PD_EN = High | | 3.6 V | 3.6 V | 118 | | 80 | 150 | kΩ | |

(1) V_{CCO} is the V_{CC} associated with the output port.(2) V_{CCI} is the V_{CC} 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 ⁽¹⁾ | 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} | | 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 ⁽¹⁾ | 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 ⁽¹⁾ | 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 ⁽¹⁾ | 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 ⁽¹⁾ | 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 | |

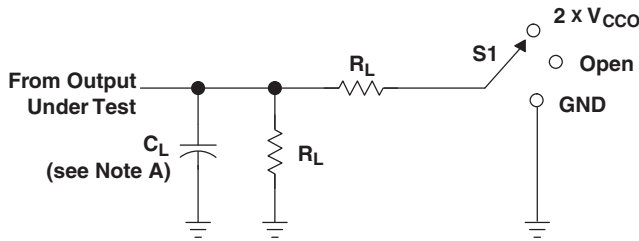
OPERATING CHARACTERISTICS

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

| 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

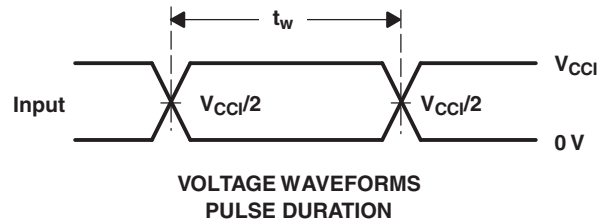
PARAMETER MEASUREMENT INFORMATION



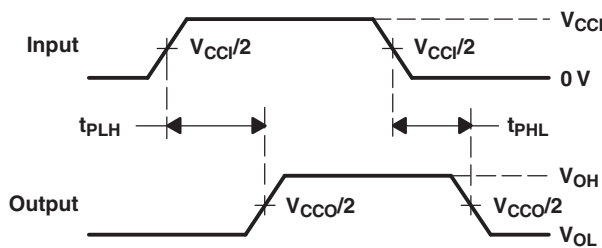
LOAD CIRCUIT

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

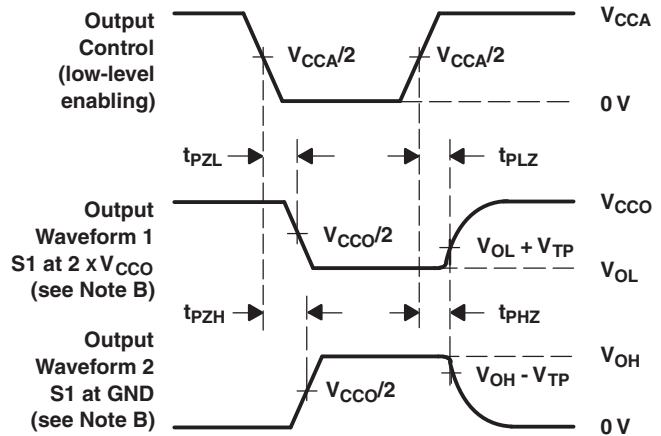
| V_{CCO} | C_L | R_L | V_{TP} |
|--------------------|-------|--------------|----------|
| 1.2 V | 18 pF | 2 k Ω | 0.1 V |
| 1.5 V \pm 0.1 V | 18 pF | 2 k Ω | 0.1 V |
| 1.8 V \pm 0.15 V | 18 pF | 2 k Ω | 0.15 V |
| 2.5 V \pm 0.2 V | 18 pF | 2 k Ω | 0.15 V |
| 3.3 V \pm 0.3 V | 18 pF | 2 k Ω | 0.3 V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



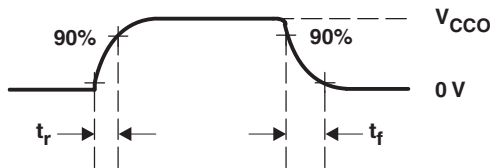
VOLTAGE WAVEFORMS PULSE DURATION



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, $Z_O = 50$ Ω , $dv/dt \geq 1$ 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)

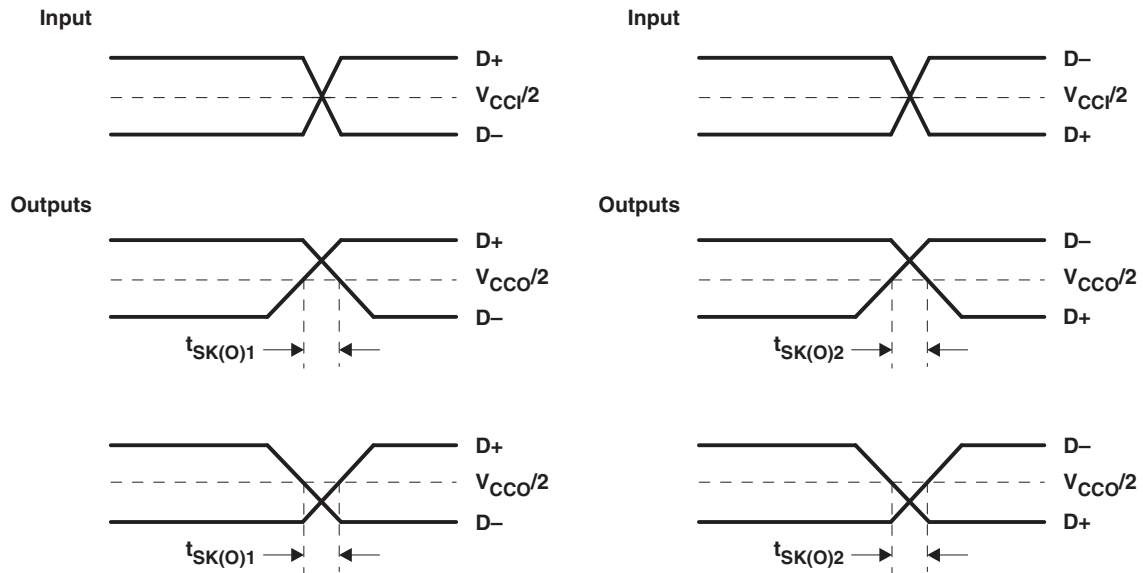


Figure 2. Output Crossover Skew

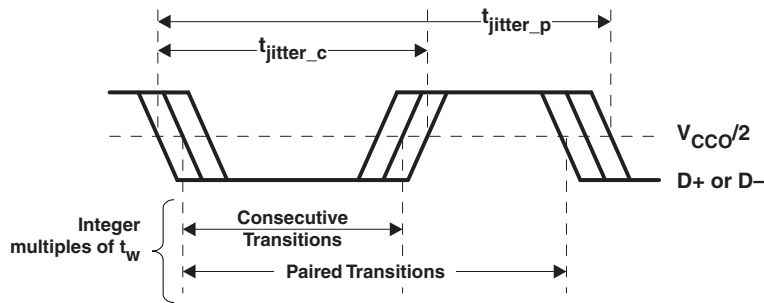


Figure 3. Output Jitter

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/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|----------------|
| SN74AVC2T872YFPR | ACTIVE | DSBGA | YFP | 12 | 3000 | Green (RoHS & no Sb/Br) | Call TI SNAGCU | Level-1-260C-UNLIM | -40 to 85 | (TU2 ~ TUN) | Samples |

(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) 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)

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

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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 | Pins | 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 | 178.0 | 9.2 | 1.28 | 1.68 | 0.62 | 4.0 | 8.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

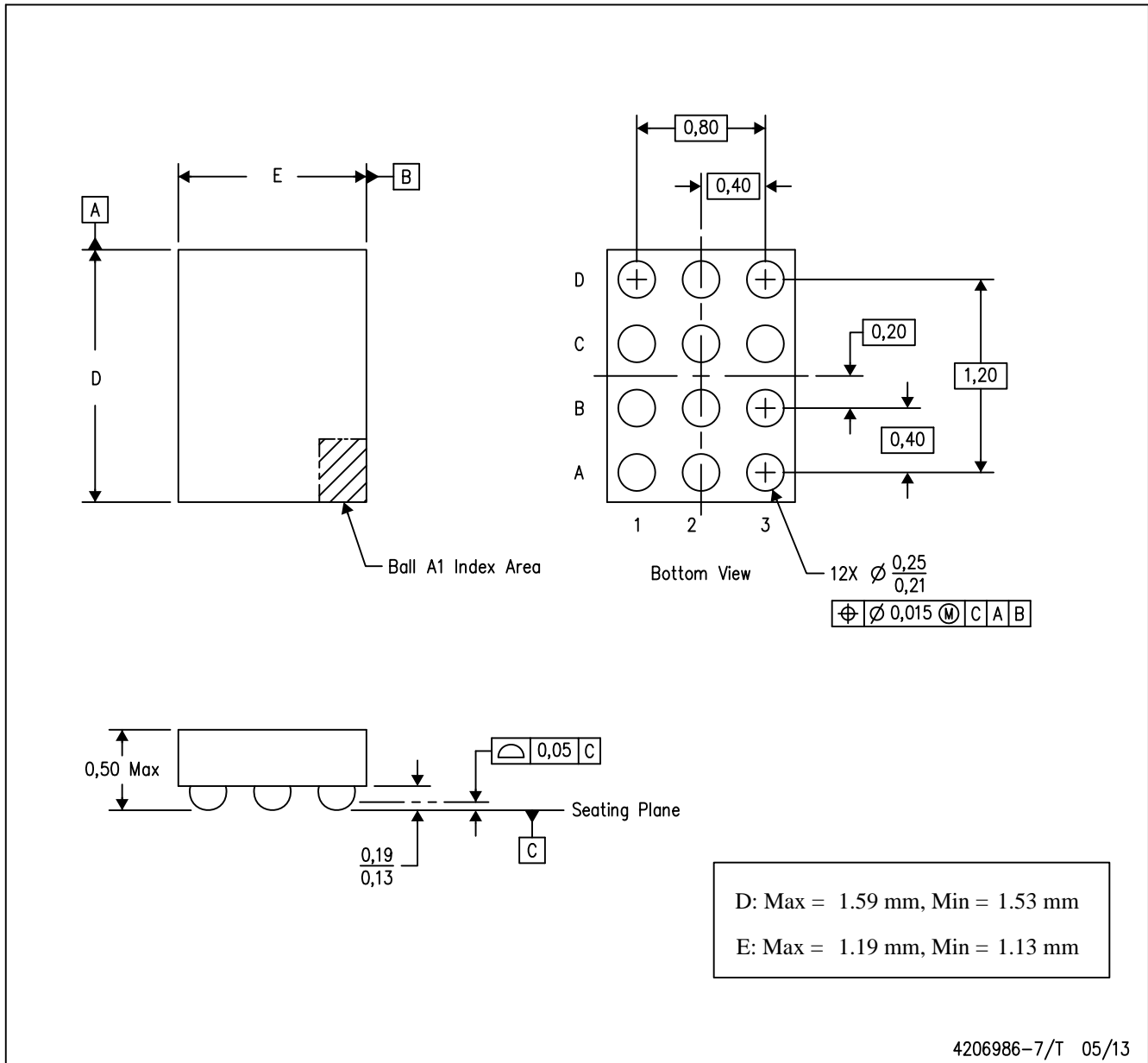


*All dimensions are nominal

| 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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