# MMC AND SD CARD VOLTAGE-TRANSLATION TRANSCEIVER

## FEATURES

- **Transceiver for Memory Card Interface [MultiMediaCard (MMC) and Secure Digital (SD) Compliant Products]**
- **Configurable I/O Switching Levels With Dual-Supply Pins Operating Over Full 1.2-V to 3.6-V Power-Supply Range**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**

- **ESD Protection**
  - **±8-kV Contact Discharge**
  - **±15-kV Air-Gap Discharge**
- **EMI Filtering**
- **Integrated Pullup and Pulldown Resistors on Card-Side I/Os per SD Specification**
- **ZQS Package Has 100-kΩ Pullup Resistors Via WP and CD Pins**

## DESCRIPTION/ORDERING INFORMATION

The SN74AVCA406E is a transceiver for interfacing microprocessors with MultiMediaCards (MMCs) and secure digital (SD) cards.

Two supply-voltage pins allow the A-port and B-port input switching thresholds to be configured separately. The A port is designed to track $V_{CCA}$, while the B port is designed to track $V_{CCB}$. $V_{CCA}$ and $V_{CCB}$ can accept any supply voltage from 1.2 V to 3.6 V.

If either $V_{CC}$ is switched off ($V_{CCA}$ = 0 V and/or $V_{CCB}$ = 0 V), all outputs are placed in the high-impedance state to conserve power.

The SN74AVCA406E enables system designers to easily interface low-voltage microprocessors to different memory cards operating at higher voltages.

Memory card standards recommend high ESD protection for devices that connect directly to the external memory card. To meet this need, the SN74AVCA406E incorporates ±15-kV Air-Gap Discharge and ±8-kV Contact Discharge protection on the card side.

The SN74AVCA406E is available in two 0.5-mm-pitch ball grid array (BGA) packages. The 20-ball package has dimensions of 3 mm × 2.5 mm, and the 24-ball package measures 3 mm × 3 mm. Memory cards are widely used in mobile phones, PDAs, digital cameras, personal media players, camcorders, set-top boxes, etc. Low static power consumption and small package size make the SN74AVCA406E an ideal choice for these applications.

### ORDERING INFORMATION

| $T_A$ | PACKAGE[(1)(2)] | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| −40°C to 85°C | UFBGA − ZXY (Pb-Free) | Reel of 2500 | SN74AVCA406EZXYR | WM406E |
| | MicroStar Junior™ BGA − ZQS (Pb-Free) | Reel of 2500 | SN74AVCA406EZQSR | WM406E |

(1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

⚠️ 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.

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**ZXY PACKAGE
(TOP VIEW)**
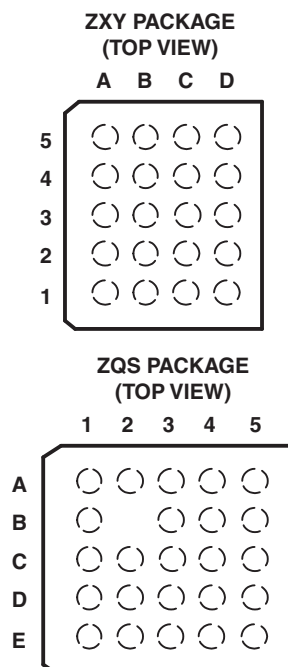
**TERMINAL ASSIGNMENTS
(20-Ball ZXY Package)**

|   | A | B | C | D |
|---|---|---|---|---|
| **5** | $V_{CCA}$ | CMD-dir | DAT0-dir | $V_{CCB}$ |
| **4** | DAT3A | DAT2A | DAT2B | DAT3B |
| **3** | CLKA | GND | GND | CLKB |
| **2** | DAT1A | DAT0A | CMDB | DAT0B |
| **1** | CLK-f | CMDA | DAT123-dir | DAT1B |

**ZQS PACKAGE
(TOP VIEW)**

**TERMINAL ASSIGNMENTS
(24-Ball ZQS Package)**

|   | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **A** | DAT2A | CMD-dir | DAT0-dir | RSV | DAT2B |
| **B** | DAT3A |  | $V_{CCA}$ | $V_{CCB}$ | DAT3B |
| **C** | CLKA | RSV | GND | GND | CLKB |
| **D** | DAT0A | CMDA | CD | CMDB | DAT0B |
| **E** | DAT1A | CLK-f | DAT123-dir | WP | DAT1B |

**REFERENCE DESIGN**
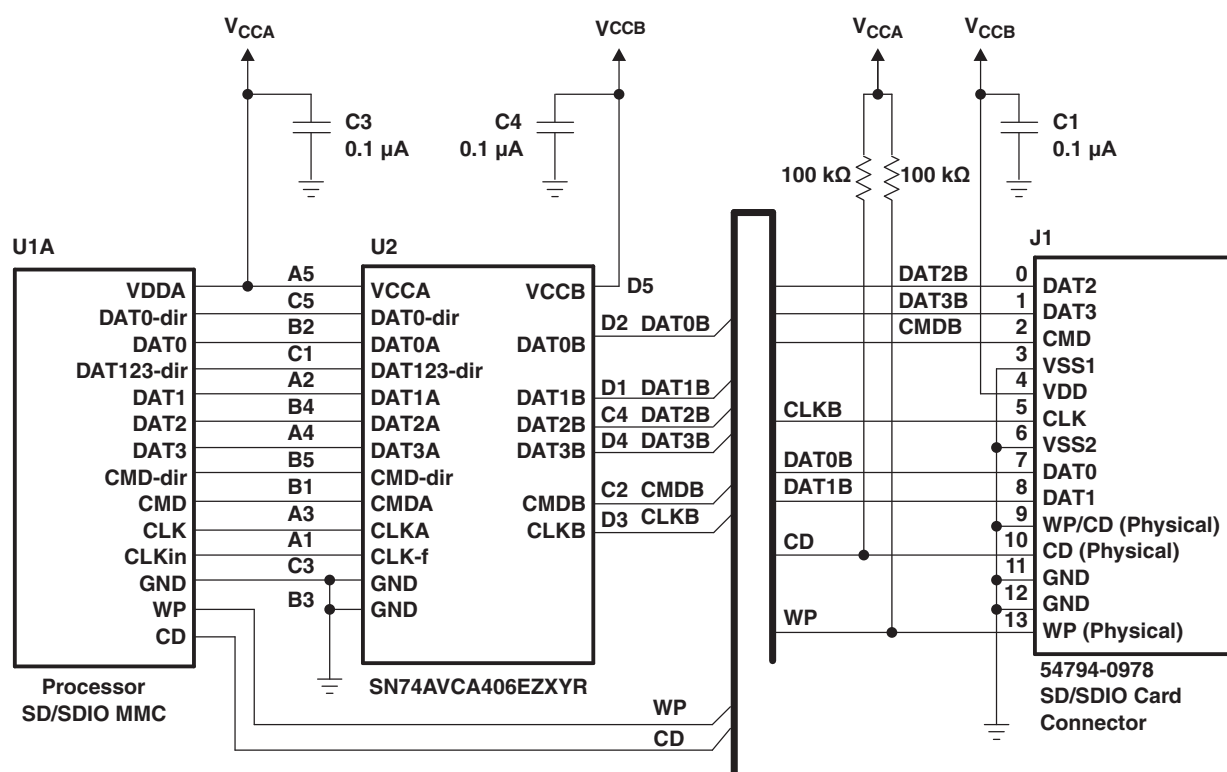


**Figure 1. Interfacing With SD/SDIO Card**

Product Folder Link(s): *SN74AVCA406E*

## PIN DESCRIPTION

| ZQS BALL NO. | ZXY BALL NO. | NAME | FUNCTION | TYPE |
|---|---|---|---|---|
| A1 | B4 | DAT2A | Data bit 3 connected to host. Referenced to $V_{CCA}$. | I/O |
| A2 | B5 | CMD-dir | Direction control for command bit (CMDA/CMDB) | Input |
| A3 | C5 | DAT0-dir | Direction control for DAT0A/DAT0B | Input |
| A4, C2 | – | RSV | Reserved (for possible future functionality). Leave unconnected. | |
| A5 | C5 | DAT2B | Data bit 3 connected to memory card. Includes a 70-kΩ pullup resistor to $V_{CCB}$. | I/O |
| B1 | A4 | DAT3A | Data bit 4 connected to host. Referenced to $V_{CCA}$. | I/O |
| B2 | – | – | Depopulated ball | |
| B3 | A5 | $V_{CCA}$ | A-port supply voltage. $V_{CCA}$ powers all A-port I/Os and control inputs. | Power |
| B4 | D5 | $V_{CCB}$ | B-port supply voltage. $V_{CCB}$ powers all B-port I/Os. | Power |
| B5 | D4 | DAT3B | Data bit 4 connected to memory card. Includes a 470-kΩ pulldown resistor to $V_{CCB}$. | I/O |
| C1 | A3 | CLKA | Clock signal connected to host. Referenced to $V_{CCA}$. | Input |
| C3 | B3 | GND | Ground | |
| C4 | C3 | GND | Ground | |
| C5 | D3 | CLKB | Clock signal connected to memory card. Referenced to $V_{CCB}$. | Output |
| D1 | B2 | DAT0A | Data bit 1 connected to host. Referenced to $V_{CCA}$. | I/O |
| D2 | B1 | CMDA | Command bit connected to host. Referenced to $V_{CCA}$. | I/O |
| D3 | – | CD | Connected to card detect on the mechanical connector. CD has an internal 100-kΩ pullup resistor to $V_{CCA}$ and this pin has ±10-kV Air-Gap Discharge and ±8-kV Contact Discharge ESD protection. | Output |
| D4 | C2 | CMDB | Command bit connected to memory card. Includes a 15-kΩ pullup resistor to $V_{CCB}$. | I/O |
| D5 | D2 | DAT0B | Data bit 1 connected to memory card. Includes a 70-kΩ pullup resistor to $V_{CCB}$. | I/O |
| E1 | A2 | DAT1A | Data bit 2 connected to host. Referenced to $V_{CCA}$. | I/O |
| E2 | A1 | CLK-f | Clock feedback to host for resynchronizing data. Used in OMAP processors. Leave unconnected if not used. | Output |
| E3 | C1 | DAT123-dir | Direction control for DAT1A/B, DAT2A/B, and DAT3A/B | Input |
| E4 | – | WP | Connected to write protect on the mechanical connector. WP has an internal 100-kΩ pullup resistor to $V_{CCA}$ and this pin has ±10-kV Air-Gap Discharge and ±8-kV Contact Discharge ESD protection. | Output |
| E5 | D1 | DAT1B | Data bit 2 connected to memory card. Includes a 70-kΩ pullup resistor to $V_{CCB}$. | I/O |

## FUNCTION TABLES

| CONTROL INPUT CMD-dir | OUTPUT CIRCUITS | | OPERATION |
|---|---|---|---|
| | CMDA | CMDB | |
| High | Hi-Z | Enabled | CMDA to CMDB |
| Low | Enabled | Hi-Z | CMDB to CMDA |

| CONTROL INPUT DAT0-dir | OUTPUT CIRCUITS | | FUNCTION |
|---|---|---|---|
| | DAT0A | DAT0B | |
| High | Hi-Z | Enabled | DAT0A to DAT0B |
| Low | Enabled | Hi-Z | DAT0B to DAT0A |

| CONTROL INPUT DAT123-dir | OUTPUT CIRCUITS | | FUNCTION |
|---|---|---|---|
| | DAT1A, DAT2A, DAT3A | DAT1B, DAT2B, DAT3B | |
| High | Hi-Z | Enabled | DAT1A to DAT1B |
| High | Hi-Z | Enabled | DAT2A to DAT2B |
| High | Hi-Z | Enabled | DAT3A to DAT3B |
| Low | Enabled | Hi-Z | DAT1B to DAT1A |
| Low | Enabled | Hi-Z | DAT2B to DAT2A |
| Low | Enabled | Hi-Z | DAT3B to DAT3A |

Product Folder Link(s): SN74AVCA406E

## LOGIC DIAGRAM (POSITIVE LOGIC)
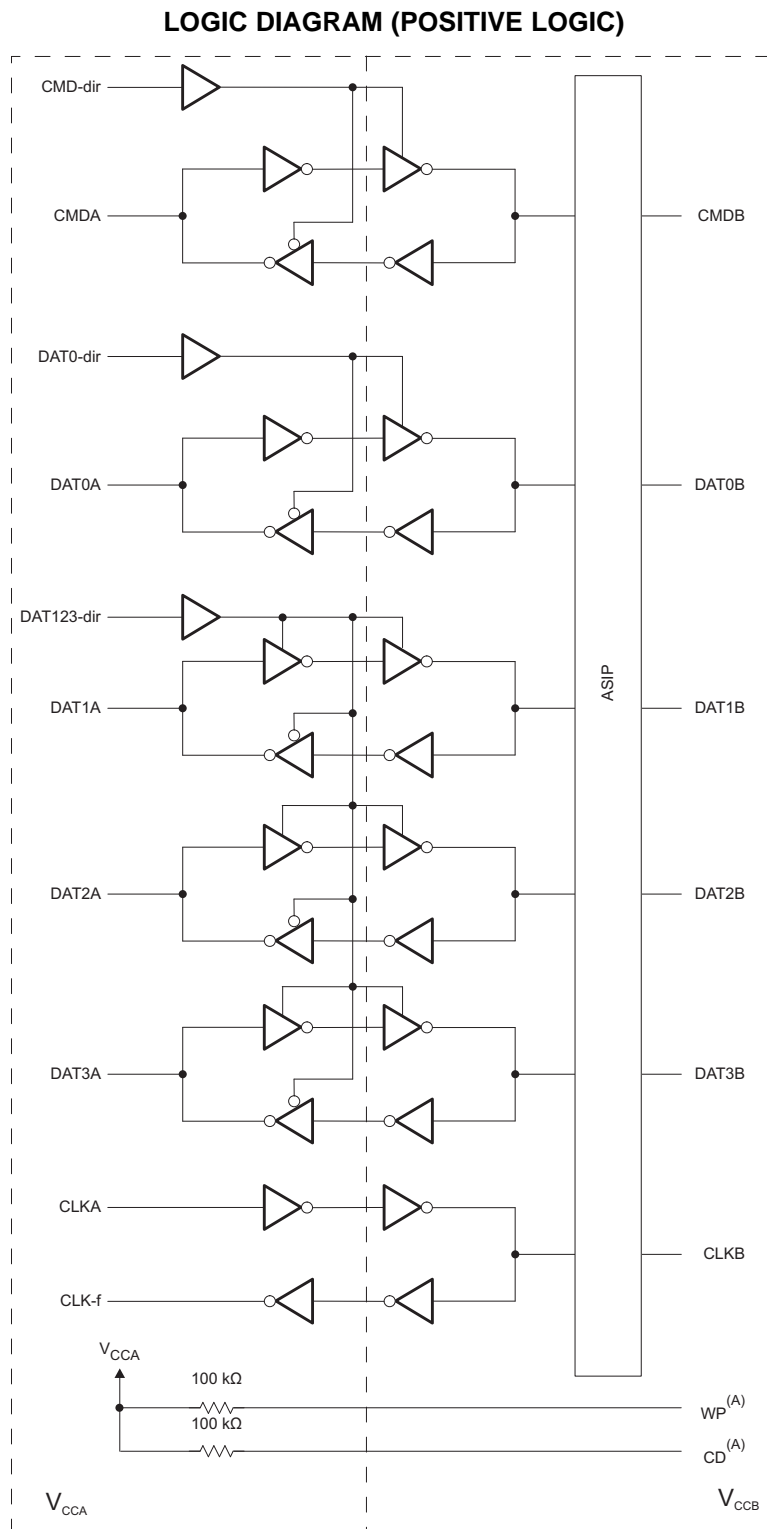


A.   WP and CD pullup resistors are for the ZQS package only.

**Figure 2. Logic Diagram**

Product Folder Link(s): SN74AVCA406E
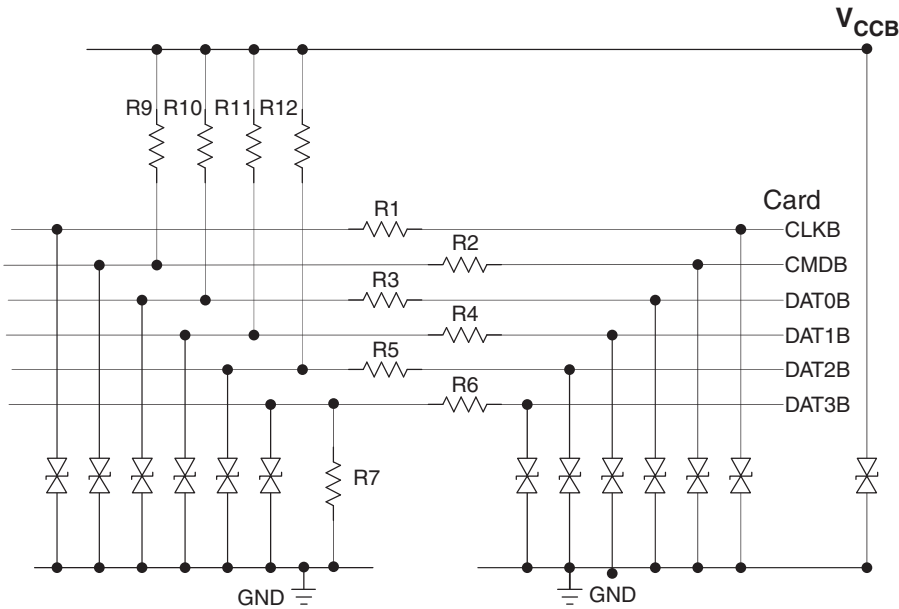
## BLOCK DIAGRAM



**Figure 3. ASIP Block Diagram**

| RESISTORS | | BIDIRECTIONAL ZENER DIODES | |
|---|---|---|---|
| R1, R2, R3, R4, R5, R6 | 40 Ω | Vbr min. | 14 V at 1 mA |
| | | Line capacitance | <20 pF |
| Tolerance | ±20% | | |
| R10, R11, R12 | 70 kΩ | | |
| R9 | 15 kΩ | | |
| R7 | 470 kΩ | | |
| Tolerance | ±30% | | |



| Resistors | |
|---|---|
| $R_{WP}$, $R_{CD}$ | 100 kΩ |
| Tolerance | ±30% |
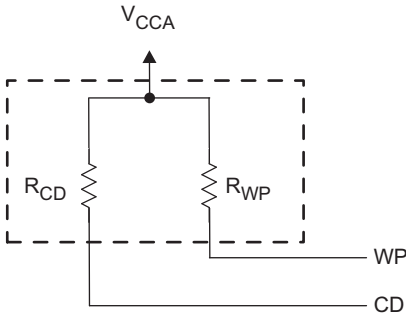
**Figure 4. WP, CD Pullup Resistors (for ZQS Package Only)**

Product Folder Link(s): *SN74AVCA406E*

## 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][3] | 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 |
| $T_{stg}$ | 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 output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current rating is observed.

## PACKAGE THERMAL IMPEDANCE

| | | | | UNIT |
|---|---|---|---|---|
| $\theta_{JA}$ | Package thermal impedance[1] | ZQS package | 171.6 | °C/W |
| | | ZXY package | 193 | |

(1) 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 |  |  |  | 1.2 | 3.6 | V |
| $V_{CCB}$ | Supply voltage |  |  |  | 1.2 | 3.6 | V |
| $V_{IH}$ | High-level input voltage | All inputs[(4)] | 1.2 V to 1.95 V |  | $V_{CCI}$ x 0.65 |  | V |
|  |  |  | 1.95 V to 2.7 V |  | 1.7 |  |  |
|  |  |  | 2.7 V to 3.6 V |  | 2 |  |  |
| $V_{IL}$ | Low-level input voltage | All inputs[(4)] | 1.2 V to 1.95 V |  |  | $V_{CCI}$ x 0.35 | V |
|  |  |  | 1.95 V to 2.7 V |  |  | 0.7 |  |
|  |  |  | 2.7 V to 3.6 V |  |  | 0.8 |  |
| $V_I$ | Input voltage | Control inputs |  |  | 0 | 3.6 | V |
| $V_{I/O}$ | Input/output voltage | Active state |  |  | 0 | $V_{CCO}$ | V |
|  |  | 3-state |  |  | 0 | 3.6 |  |
| $I_{OH}$ | High-level output current (A port) |  |  | 1.2 V |  | −1 | mA |
|  |  |  |  | 1.4 V to 1.6 V |  | −1 |  |
|  |  |  |  | 1.65 V to 1.95 V |  | −2 |  |
|  |  |  |  | 2.3 V to 2.7 V |  | −4 |  |
|  |  |  |  | 3 V to 3.6 V |  | −8 |  |
| $I_{OL}$ | Low-level output current (A port) |  |  | 1.2 V |  | 1 | mA |
|  |  |  |  | 1.4 V to 1.6 V |  | 1 |  |
|  |  |  |  | 1.65 V to 1.95 V |  | 2 |  |
|  |  |  |  | 2.3 V to 2.7 V |  | 4 |  |
|  |  |  |  | 3 V to 3.6 V |  | 8 |  |
| $I_{OH}$ | High-level output current (B port) |  |  | 1.2 V |  | −1 | mA |
|  |  |  |  | 1.4 V to 1.6 V |  | −2 |  |
|  |  |  |  | 1.65 V to 1.95 V |  | −4 |  |
|  |  |  |  | 2.3 V to 2.7 V |  | −8 |  |
|  |  |  |  | 3 V to 3.6 V |  | −16 |  |
| $I_{OL}$ | Low-level output current (B port) |  |  | 1.2 V |  | 1 | mA |
|  |  |  |  | 1.4 V to 1.6 V |  | 2 |  |
|  |  |  |  | 1.65 V to 1.95 V |  | 4 |  |
|  |  |  |  | 2.3 V to 2.7 V |  | 8 |  |
|  |  |  |  | 3 V to 3.6 V |  | 16 |  |
| Δt/Δv | 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. Refer to the TI application report,
       *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.
(4)    CMD-dir, DAT0-dir, and DAT123-dir are referenced to $V_{CCA}$.

Product Folder Link(s): *SN74AVCA406E*

## ELECTRICAL CHARACTERISTICS

over recommended operating free-air temperature range (unless otherwise noted)[1][2]

| PARAMETER | | TEST CONDITIONS | | $V_{CCA}$ | $V_{CCB}$ | MIN | TYP[3] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | A port | $I_{OH} = -100$ μA | $V_I = V_{IH}$ | 1.2 V to 3.6 V | 1.2 V to 3.6 V | $V_{CCO} - 0.2$ | | | V |
| | | $I_{OH} = -1$ mA | | 1.2 V | 1.2 V | 0.9 | | | |
| | | $I_{OH} = -1$ mA | | 1.4 V | 1.4 V | 1.05 | | | |
| | | $I_{OH} = -2$ mA | | 1.65 V | 1.65 V | 1.2 | | | |
| | | $I_{OH} = -4$ mA | | 2.3 V | 2.3 V | 1.75 | | | |
| | | $I_{OH} = -8$ mA | | 3 V | 3 V | 2.3 | | | |
| $V_{OL}$ | A port | $I_{OL} = 100$ μA | $V_I = V_{IL}$ | 1.2 V to 3.6 V | 1.2 V to 3.6 V | | | 0.2 | V |
| | | $I_{OL} = 1$ mA | | 1.2 V | 1.2 V | | | 0.1 | |
| | | $I_{OL} = 1$ mA | | 1.4 V | 1.4 V | | | 0.35 | |
| | | $I_{OL} = 2$ mA | | 1.65 V | 1.65 V | | | 0.45 | |
| | | $I_{OL} = 4$ mA | | 2.3 V | 2.3 V | | | 0.55 | |
| | | $I_{OL} = 8$ mA | | 3 V | 3 V | | | 0.7 | |
| $V_{OH}$ | B port | $I_{OH} = -100$ μA | $V_I = V_{IH}$ | 1.2 V to 3.6 V | 1.2 V to 3.6 V | $V_{CCO} - 0.2$ | | | V |
| | | $I_{OH} = -1$ mA | | 1.2 V | 1.2 V | 1.1 | | | |
| | | $I_{OH} = -2$ mA | | 1.4 V | 1.4 V | 1.05 | | | |
| | | $I_{OH} = -4$ mA | | 1.65 V | 1.65 V | 1.2 | | | |
| | | $I_{OH} = -8$ mA | | 2.3 V | 2.3 V | 1.75 | | | |
| | | $I_{OH} = -16$ mA | | 3 V | 3 V | 2.1 | | | |
| $V_{OL}$ | B port | $I_{OL} = 100$ μA | $V_I = V_{IL}$ | 1.2 V to 3.6 V | 1.2 V to 3.6 V | | | 0.2 | V |
| | | $I_{OL} = 1$ mA | | 1.2 V | 1.2 V | | | 0.07 | |
| | | $I_{OL} = 2$ mA | | 1.4 V | 1.4 V | | | 0.35 | |
| | | $I_{OL} = 4$ mA | | 1.65 V | 1.65 V | | | 0.45 | |
| | | $I_{OL} = 8$ mA | | 2.3 V | 2.3 V | | | 0.55 | |
| | | $I_{OL} = 16$ mA | | 3 V | 3 V | | | 0.79 | |
| $I_I$ | Control inputs | $V_I = V_{CCA}$ or GND | | 1.2 V to 3.6 V | 1.2 V to 3.6 V | | | ±1 | μA |
| $I_{OZ}$[4] | A or B port | $V_O = V_{CCO}$ or GND, $V_I = V_{CCI}$ or GND | See function table for input states when outputs are Hi Z | 3.6 V | 3.6 V | | | ±5 | μA |
| $I_{CCA}$ | | $V_I = V_{CCI}$ or GND, $I_O = 0$ | | 1.2 V to 3.6 V | 1.2 V to 3.6 V | | | 10 | μA |
| | | | | 3.6 V | 0 V | | | 10 | |
| | | | | 0 V | 3.6 V | | | −1 | |
| $I_{CCB}$ | | $V_I = V_{CCI}$ or GND, $I_O = 0$ | | 1.2 V to 3.6 V | 1.2 V to 3.6 V | | | 10 | μA |
| | | | | 3.6 V | 0 V | | | −1 | |
| | | | | 0 V | 3.6 V | | | 10 | |
| $I_{CCA} + I_{CCB}$ | | $V_I = V_{CCI}$ or GND, $I_O = 0$ | | 1.2 V to 3.6 V | 1.2 V to 3.6 V | | | 15 | μA |
| $C_i$ | Control inputs | $V_I = V_{CCA}$ or GND | | 1.8 V | 3 V | | 1.5 | 2 | pF |
| | Clock input | | | | | | 1.5 | 2 | |
| $C_{io}$ | A port | $V_O = V_{CCA}$ or GND | | 1.8 V | 3 V | | 2.5 | 3.5 | pF |
| | B port | $V_O = V_{CCB}$ or GND | | | | | 12 | 14 | |

(1)  $V_{CCO}$ is the $V_{CC}$ associated with the output port.
(2)  $V_{CCI}$ is the $V_{CC}$ associated with the data input port.
(3)  All typical values are at $T_A = 25°C$.
(4)  For I/O ports, the parameter $I_{OZ}$ includes the input leakage current.

## OUTPUT SLEW RATES

over recommended operating free-air temperature range (unless otherwise noted)[1]

| PARAMETER | FROM | TO | $V_{CCA}$ = 1.8 V ± 0.15 V, $V_{CCB}$ = 3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| $t_r$ | 20% | 80% | | 2.7[2] | ns |
| $t_f$ | 80% | 20% | | 2.5[2] | ns |

(1)  Values are characterized, but not production tested.
(2)  Using $C_L$ = 30 pF on the B side and $C_L$ = 7 pF on the A side

## TYPICAL SWITCHING CHARACTERISTICS

$T_A$ = 25°C, $V_{CCA}$ = 1.2 V (see Figure 6)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 1.2 V | $V_{CCB}$ = 1.5 V | $V_{CCB}$ = 1.8 V | $V_{CCB}$ = 2.5 V | $V_{CCB}$ = 3 V | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | TYP | TYP | TYP | TYP | TYP | |
| $t_{pd}$ | A | B | 4.9 | 4 | 3.5 | 3.2 | 3.2 | ns |
| | B | A | 5.3 | 4.3 | 4.1 | 3.9 | 3.9 | |
| | CLKA | CLKB | 5.1 | 4 | 3.5 | 3.1 | 3.1 | |
| | | CLK-f | 10.3 | 8.9 | 7.7 | 7.7 | 7.7 | |
| | CMDA | CMDB | 4.9 | 4 | 3.5 | 3.2 | 3.2 | |
| | CMDB | CMDA | 4.8 | 4.4 | 4.2 | 4 | 4 | |
| $t_{en}$[1] | DIR | A | 5.3 | 5.4 | 5.2 | 6 | 5.9 | ns |
| $t_{dis}$[1] | DIR | A | 5.5 | 5.4 | 5.5 | 5.6 | 5.5 | ns |

(1)  DIR refers to CMD-dir, DAT0-dir, and DAT123-dir.

## SWITCHING CHARACTERISTICS
## $V_{CCA}$ = 1.5 V ± 0.1 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 1.5 V ± 0.1 V | | $V_{CCB}$ = 1.8 V ± 0.15 V | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A | B | 1.2 | 7.2 | 0.8 | 6.3 | 0.8 | 5.4 | 0.9 | 5.1 | 0.9 | 5.1 | ns |
| | B | A | 1.1 | 6.2 | 1 | 7.2 | 0.93 | 6.6 | 0.45 | 7 | 0.45 | 7 | |
| | CLKA | CLKB | 1.4 | 7.1 | 1.1 | 6.2 | 0.8 | 5.3 | 0.7 | 5.1 | 0.7 | 5.1 | |
| | | CLK-f | 1.1 | 12.7 | 1.3 | 13.3 | 1.3 | 10.6 | 1.9 | 10.9 | 1.9 | 10.9 | |
| | CMDA | CMDB | 1.1 | 6 | 0.9 | 5.6 | 0.7 | 4.7 | 0.6 | 4.1 | 0.6 | 4.1 | |
| | CMDB | CMDA | 0.8 | 5.9 | 0.8 | 6.8 | 0.8 | 6.4 | 0.1 | 6.7 | 0.1 | 6.7 | |
| $t_{en}$[1] | DIR | A | 1.0 | 9.1 | 1.1 | 10.3 | 1.1 | 8.7 | 1.1 | 11 | 1.1 | 11 | ns |
| $t_{dis}$[1] | DIR | A | 1.1 | 8.1 | 1.1 | 8.3 | 1.1 | 8.3 | 1.1 | 8.3 | 1.1 | 8.3 | ns |

(1)  DIR refers to CMD-dir, DAT0-dir, and DAT123-dir.

Product Folder Link(s): *SN74AVCA406E*

## SWITCHING CHARACTERISTICS
## $V_{CCA}$ = 1.8 V ± 0.15 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 1.8 V ± 0.15 V | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A | B | 0.7 | 5.8 | 0.6 | 4.9 | 0.5 | 4.7 | 0.5 | 4.7 | ns |
| | B | A | 0.7 | 4.9 | 0.7 | 4.5 | 0.2 | 5.2 | 0.2 | 5.2 | |
| | CLKA | CLKB | 0.9 | 5.8 | 0.6 | 4.9 | 0.6 | 4.7 | 0.6 | 4.7 | |
| | | CLK-f | 0.9 | 11 | 0.9 | 9.2 | 0.8 | 8.8 | 0.8 | 8.8 | |
| | CMDA | CMDB | 0.7 | 4.3 | 0.5 | 4.1 | 0.5 | 3.4 | 0.5 | 3.4 | |
| | CMDB | CMDA | 0.7 | 4.6 | 0.8 | 4.2 | 0.1 | 5 | 0.1 | 5 | |
| $t_{en}$[1] | DIR | A | 0.7 | 7.2 | 0.7 | 6.6 | 0.7 | 7.8 | 0.7 | 7.8 | ns |
| $t_{dis}$[1] | DIR | A | 1.0 | 7.9 | 1 | 7.7 | 1 | 8.2 | 1 | 8.2 | ns |

(1)   DIR refers to CMD-dir, DAT0-dir, and DAT123-dir.

## SWITCHING CHARACTERISTICS
## $V_{CCA}$ = 2.5 V ± 0.2 V

over recommended operating free-air temperature range(see Figure 6)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A | B | 0.5 | 4.3 | 0.4 | 4.1 | 0.4 | 4.1 | ns |
| | B | A | 0.5 | 3.5 | 0.2 | 3.7 | 0.2 | 3.7 | |
| | CLKA | CLKB | 0.5 | 4.3 | 0.4 | 4.1 | 0.4 | 4.1 | |
| | | CLK-f | 0.4 | 7.8 | 0.3 | 7.3 | 0.3 | 7.3 | |
| | CMDA | CMDB | 0.3 | 3 | 0.3 | 2.7 | 0.3 | 2.7 | |
| | CMDB | CMDA | 0.7 | 3 | 0.2 | 3.4 | 0.2 | 3.4 | |
| $t_{en}$[1] | DIR | A | 0.5 | 5.1 | 0.5 | 5.6 | 0.5 | 5.6 | ns |
| $t_{dis}$[1] | DIR | A | 0.7 | 5.7 | 0.7 | 6.7 | 0.7 | 6.7 | ns |

(1)   DIR refers to CMD-dir, DAT0-dir, and DAT123-dir.

## SWITCHING CHARACTERISTICS
## $V_{CCA}$ = 3.3 V ± 0.3 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A | B | 0.3 | 3.8 | 0.3 | 3.8 | ns |
| | B | A | 0.3 | 3 | 0.3 | 3 | |
| | CLKA | CLKB | 0.3 | 3.8 | 0.3 | 3.8 | |
| | | CLK-f | 0.1 | 6.7 | 0.1 | 6.7 | |
| | CMDA | CMDB | 0.2 | 2.5 | 0.2 | 2.5 | |
| | CMDB | CMDA | 0.4 | 2.6 | 0.4 | 2.6 | |
| $t_{en}$[1] | DIR | A | 0.3 | 4.5 | 0.3 | 4.5 | ns |
| $t_{dis}$[1] | DIR | A | 0.9 | 7.9 | 0.9 | 7.9 | ns |

(1)   DIR refers to CMD-dir, DAT0-dir, and DAT123-dir.

## TYPICAL FREQUENCY AND OUTPUT SKEW

$T_A$ = 25°C, $V_{CCA}$ = 1.2 V (see Figure 6)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 1.2 V | $V_{CCB}$ = 1.5 V | $V_{CCB}$ = 1.8 V | $V_{CCB}$ = 2.5 V | $V_{CCB}$ = 3 V | $V_{CCB}$ = 3.3 V | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TYP | TYP | TYP | TYP | TYP | TYP | |
| $t_{max}$ | Clock | CLKA | CLKB | 95 | 95 | 95 | 95 | 95 | 95 | MHz |
| | | | CLK-f | 95 | 95 | 95 | 95 | 95 | 95 | |
| | Data | A | B | 95 | 95 | 95 | 95 | 95 | 95 | |
| | | B | A | 95 | 95 | 95 | 95 | 95 | 95 | |
| $t_{sk(o)}$ | Channel-to-channel | A | B | 0.1 | 0.1 | 0.1 | 0.3 | 0.2 | | ns |

## MAXIMUM FREQUENCY AND OUTPUT SKEW
## $V_{CCA}$ = 1.5 V ± 0.1 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 1.5 V ± 0.1 V | | $V_{CCB}$ = 1.8 V ± 0.15 V | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| $f_{max}$ | Clock | CLKA | CLKB | 95 | | 95 | | 95 | | 95 | | 95 | | MHz |
| | | | CLK-f | 95 | | 95 | | 95 | | 95 | | 95 | | |
| | Data | A | B | 95 | | 95 | | 95 | | 95 | | 95 | | |
| | | B | A | 95 | | 95 | | 95 | | 95 | | 95 | | |
| $t_{sk(o)}$ | Channel-to-channel | A | B | | 0.1 | | 0.1 | | 0.1 | | 0.1 | | | ns |

## MAXIMUM FREQUENCY AND OUTPUT SKEW
## $V_{CCA}$ = 1.8 V ± 0.15 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 1.8 V ± 0.15 V | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| $f_{max}$ | Clock | CLKA | CLKB | 95 | | 95 | | 95 | | 95 | | MHz |
| | | | CLK-f | 95 | | 95 | | 95 | | 95 | | |
| | Data | A | B | 95 | | 95 | | 95 | | 95 | | |
| | | B | A | 95 | | 95 | | 95 | | 95 | | |
| $t_{sk(o)}$ | Channel-to-channel | A | B | | 0.1 | | 0.2 | | 0.2 | | | ns |

Product Folder Link(s): *SN74AVCA406E*

## MAXIMUM FREQUENCY AND OUTPUT SKEW
### $V_{CCA}$ = 2.5 V ± 0.2 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| $f_{max}$ | Clock | CLKA | CLKB | 95 | | 95 | | 95 | | MHz |
| | | | CLK-f | 95 | | 95 | | 95 | | |
| | Data | A | B | 95 | | 95 | | 95 | | |
| | | B | A | 95 | | 95 | | 95 | | |
| $t_{sk(o)}$ | Channel-to-channel | A | B | | 0.1 | | 0.3 | | 0.3 | ns |

## MAXIMUM FREQUENCY AND OUTPUT SKEW
### $V_{CCA}$ = 3.3 V ± 0.3 V

over recommended operating free-air temperature range (see Figure 6)

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | $V_{CCB}$ = 3 V ± 0.3 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | |
| $f_{max}$ | Clock | CLKA | CLKB | 95 | | 95 | | MHz |
| | | | CLK-f | 95 | | 95 | | |
| | Data | A | B | 95 | | 95 | | |
| | | B | A | 95 | | 95 | | |
| $t_{sk(o)}$ | Channel-to-channel | A | B | | 0.3 | | | ns |

## OPERATING CHARACTERISTICS

$T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | $V_{CCA}$ = $V_{CCB}$ = 1.2 V | $V_{CCA}$ = $V_{CCB}$ = 1.5 V | $V_{CCA}$ = $V_{CCB}$ = 1.8 V | $V_{CCA}$ = $V_{CCB}$ = 2.5 V | $V_{CCA}$ = $V_{CCB}$ = 3 V | $V_{CCA}$ = $V_{CCB}$ = 3.3 V | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | TYP | TYP | TYP | TYP | TYP | TYP | |
| $C_{pdA}$ [1] | A-port input, B-port output | $C_L$ = 0, f = 10 MHz, $t_r$ = $t_f$ = 1 ns | 4.5 | 4.7 | 4.9 | 5.5 | 6 | 6.4 | pF |
| | B-port input, A-port output | | 8 | 8.3 | 8.5 | 9.1 | 9.5 | 9.7 | |
| $C_{pdB}$ [1] | A-port input, B-port output | $C_L$ = 0, f = 10 MHz, $t_r$ = $t_f$ = 1 ns | 27.9 | 27.8 | 27.7 | 27.6 | 27.6 | 27.5 | pF |
| | B-port input, A-port output | | 2.6 | 2.5 | 2.4 | 2.3 | 1.8 | 1.8 | |

(1)   Power dissipation capacitance per transceiver
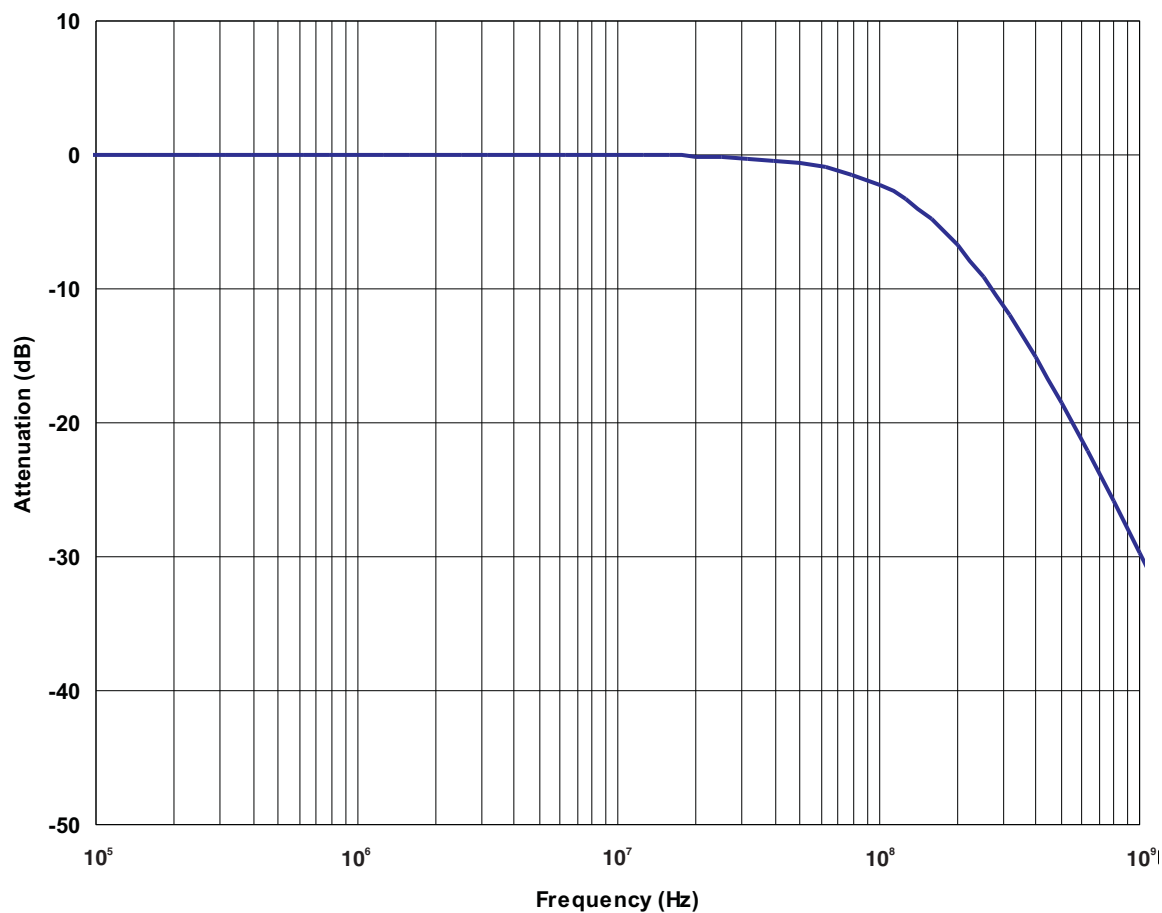
**Figure 5. Typical ASIP EMI Filter Frequency Response**

Product Folder Link(s): *SN74AVCA406E*

## PARAMETER MEASUREMENT INFORMATION



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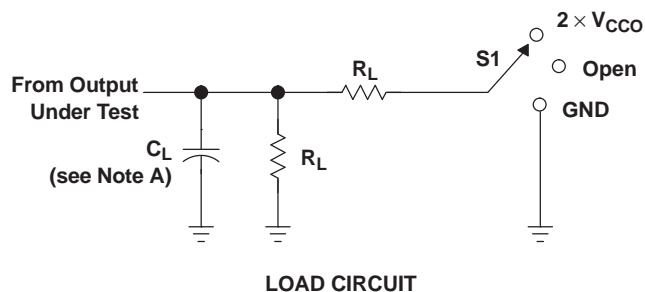
| TEST | S1 |
|---|---|
| $t_{pd}$ | Open |
| $t_{PLZ}/t_{PZL}$ | $2 \times V_{CCO}$ |
| $t_{PHZ}/t_{PZH}$ | GND |

| $V_{CCO}$ | $C_L$ | $R_L$ | $V_{TP}$ |
|---|---|---|---|
| $1.5\ V \pm 0.1\ V$ | 15 pF | 2 k$\Omega$ | 0.1 V |
| $1.8\ V \pm 0.15\ V$ | 15 pF | 2 k$\Omega$ | 0.15 V |
| $2.5\ V \pm 0.2\ V$ | 15 pF | 2 k$\Omega$ | 0.15 V |
| $3.3\ V \pm 0.3\ V$ | 15 pF | 2 k$\Omega$ | 0.3 V |

**VOLTAGE WAVEFORMS**
**PROPAGATION DELAY TIMES**

**VOLTAGE WAVEFORMS**
**ENABLE AND DISABLE TIMES**
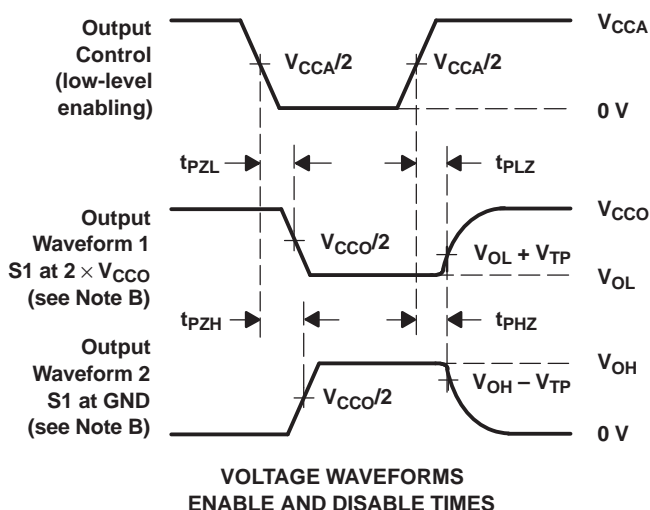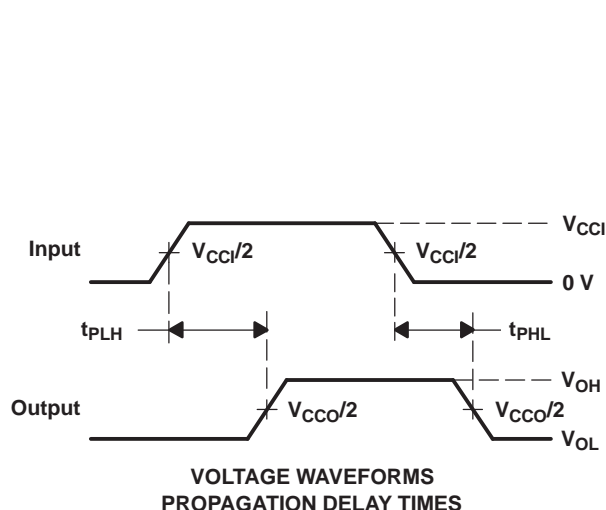
NOTES:  A.  $C_L$ includes probe and jig capacitance.
        B.  Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control.
           Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
        C.  All input pulses are supplied by generators having the following characteristics: PRR $\leq$ 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 $t_{en}$.
        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 6. Load Circuit and Voltage Waveforms**

# PACKAGE OPTION ADDENDUM

## PACKAGING INFORMATION

| Orderable Device | Status [1] | Package Type | Package Drawing | Pins | Package Qty | Eco Plan [2] | Lead/Ball Finish | MSL Peak Temp [3] |
|---|---|---|---|---|---|---|---|---|
| SN74AVCA406EZQSR | ACTIVE | BGA MICROSTAR JUNIOR | ZQS | 24 | 2500 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM |
| SN74AVCA406EZXYR | ACTIVE | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM |

[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.
**OBSOLETE:** 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.

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# PACKAGE MATERIALS INFORMATION

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**



**TAPE DIMENSIONS**



| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**
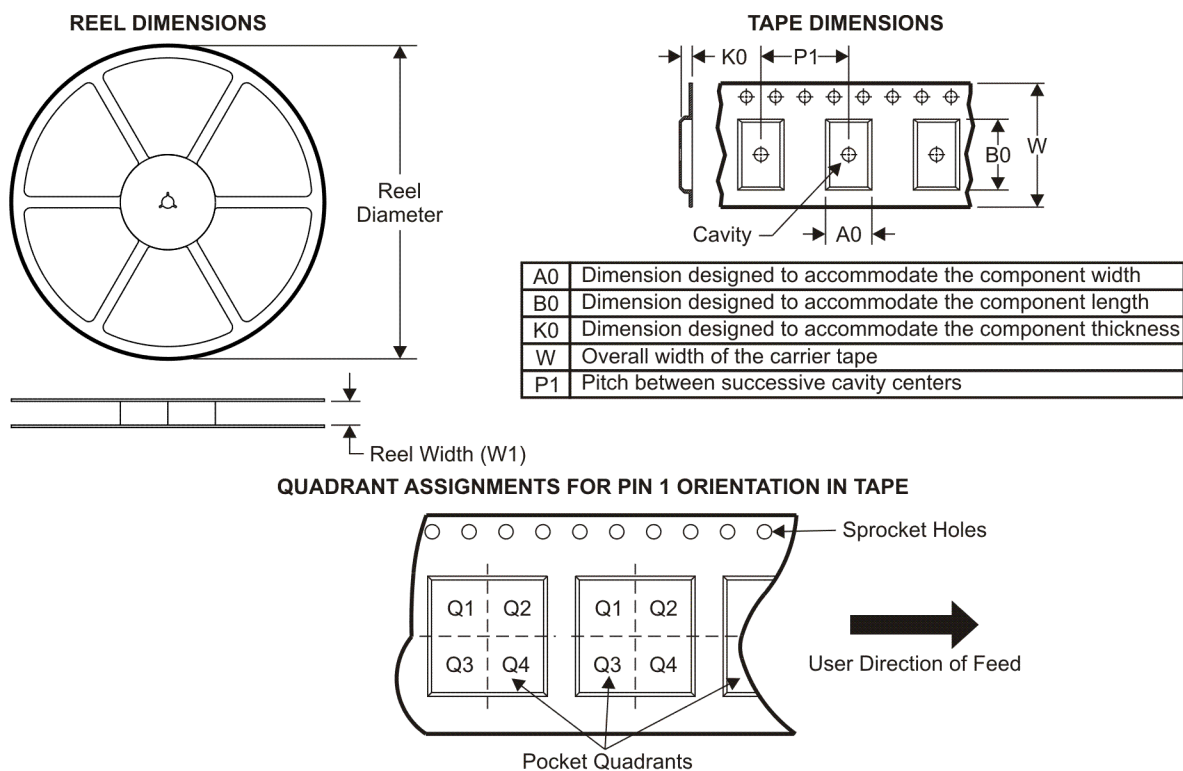


*All dimensions are nominal

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SN74AVCA406EZQSR | BGA MICROSTAR JUNIOR | ZQS | 24 | 2500 | 330.0 | 12.4 | 3.3 | 3.3 | 1.6 | 8.0 | 12.0 | Q1 |
| SN74AVCA406EZXYR | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | 330.0 | 12.4 | 2.8 | 3.3 | 1.0 | 4.0 | 12.0 | Q2 |

**TAPE AND REEL BOX  DIMENSIONS**



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| SN74AVCA406EZQSR | BGA MICROSTAR JUNIOR | ZQS | 24 | 2500 | 340.5 | 338.1 | 20.6 |
| SN74AVCA406EZXYR | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | 340.5 | 338.1 | 20.6 |

## ZQS (S−PBGA−N24)                    PLASTIC BALL GRID ARRAY

$\frac{3,10}{2,90}$ SQ

A1 Corner

2,00 TYP

0,50

0,50

2,00 TYP

E
D
C
B
A

1  2  3  4  5

Bottom View

$\frac{0,77}{0,71}$

1,00 MAX

Seating Plane

$\frac{0,35}{0,25}$

$\frac{0,25}{0,15}$

⌒ 0,08

⊕ ⌀ 0,05 Ⓜ
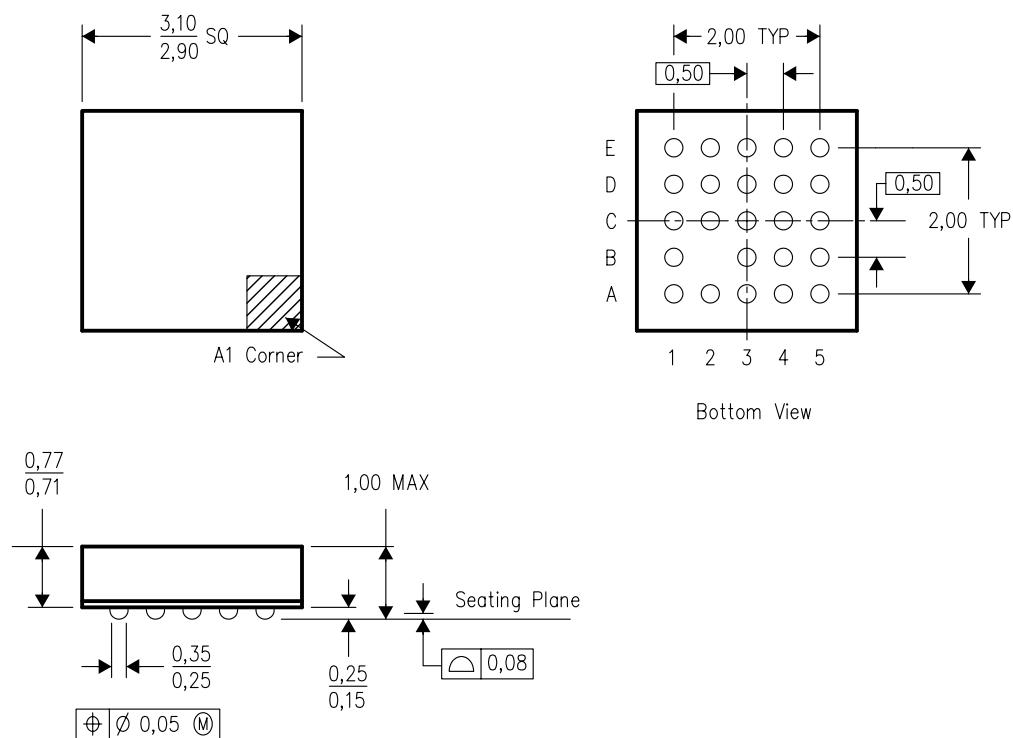
4206374/A 09/04

NOTES:   A.   All linear dimensions are in millimeters.
         B.   This drawing is subject to change without notice.
         C.   Falls within JEDEC MO−225
         D.   This package is lead−free.

## ZXY (S−PBGA−N20)                    PLASTIC BALL GRID ARRAY
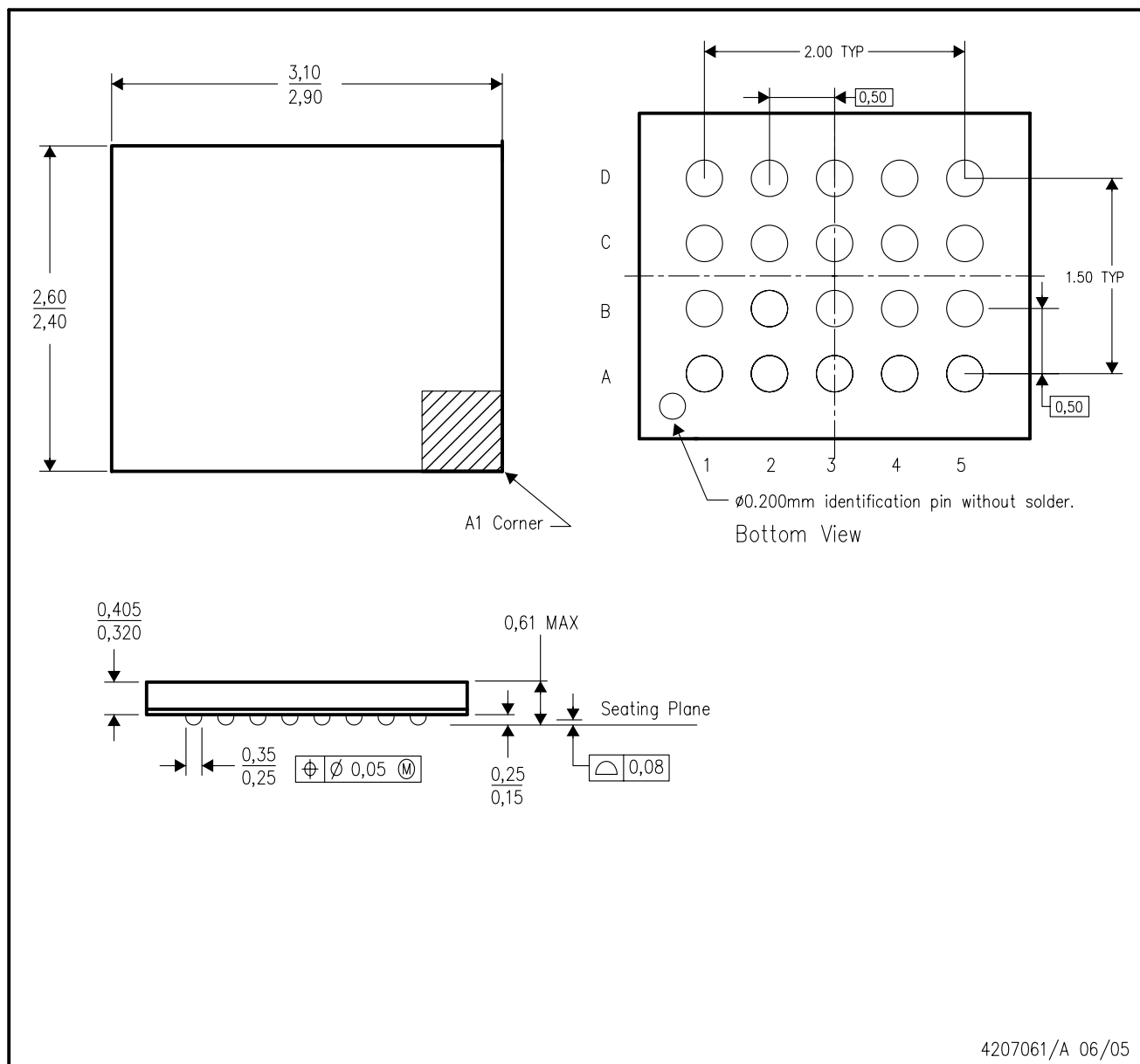
$\dfrac{3,10}{2,90}$

$\dfrac{2,60}{2,40}$

A1 Corner

2.00 TYP

0,50

D

C

1.50 TYP

B

A

0,50

1    2    3    4    5

ø0.200mm identification pin without solder.

Bottom View

$\dfrac{0,405}{0,320}$

0,61 MAX

Seating Plane

$\dfrac{0,35}{0,25}$    ⊕ | Ø 0,05 Ⓜ

$\dfrac{0,25}{0,15}$

◁ | 0,08

4207061/A 06/05

NOTES:  A.  All linear dimensions are in millimeters.
        B.  This drawing is subject to change without notice.
        C.  This package is a lead−free solder ball design.