

## 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 <sup>(1)(2)</sup>		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](http://www.ti.com/packaging).

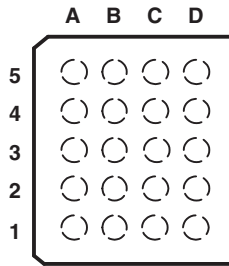
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).



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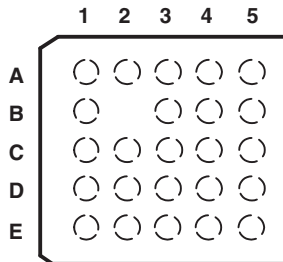
**ZXY PACKAGE  
(TOP VIEW)**



**TERMINAL ASSIGNMENTS  
(20-Ball ZXY Package)**

	A	B	C	D
5	V <sub>CCA</sub>	CMD-dir	DAT0-dir	V <sub>CCB</sub>
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 <sub>CCA</sub>	V <sub>CCB</sub>	DAT3B
C	CLKA	RSV	GND	GND	CLKB
D	DAT0A	CMDA	CD	CMDB	DAT0B
E	DAT1A	CLK-f	DAT123-dir	WP	DAT1B

**REFERENCE DESIGN**

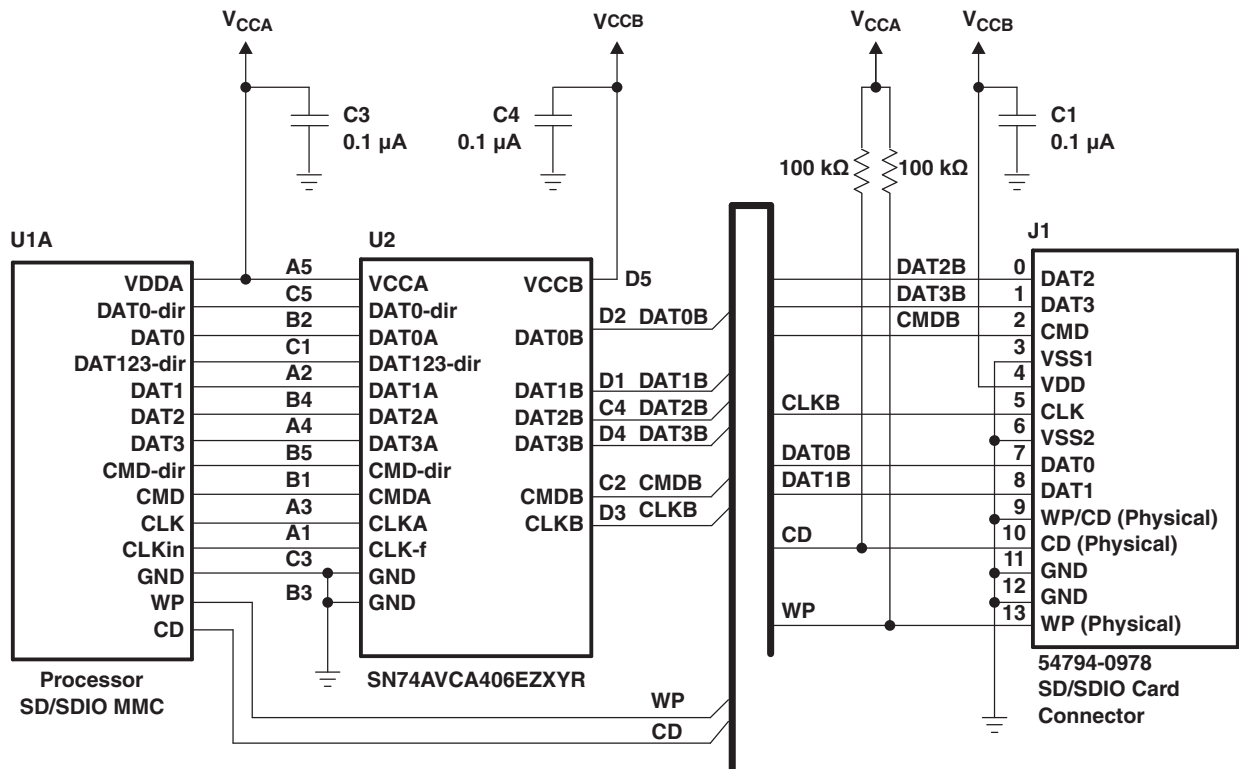


Figure 1. Interfacing With SD/SDIO Card

**PIN DESCRIPTION**

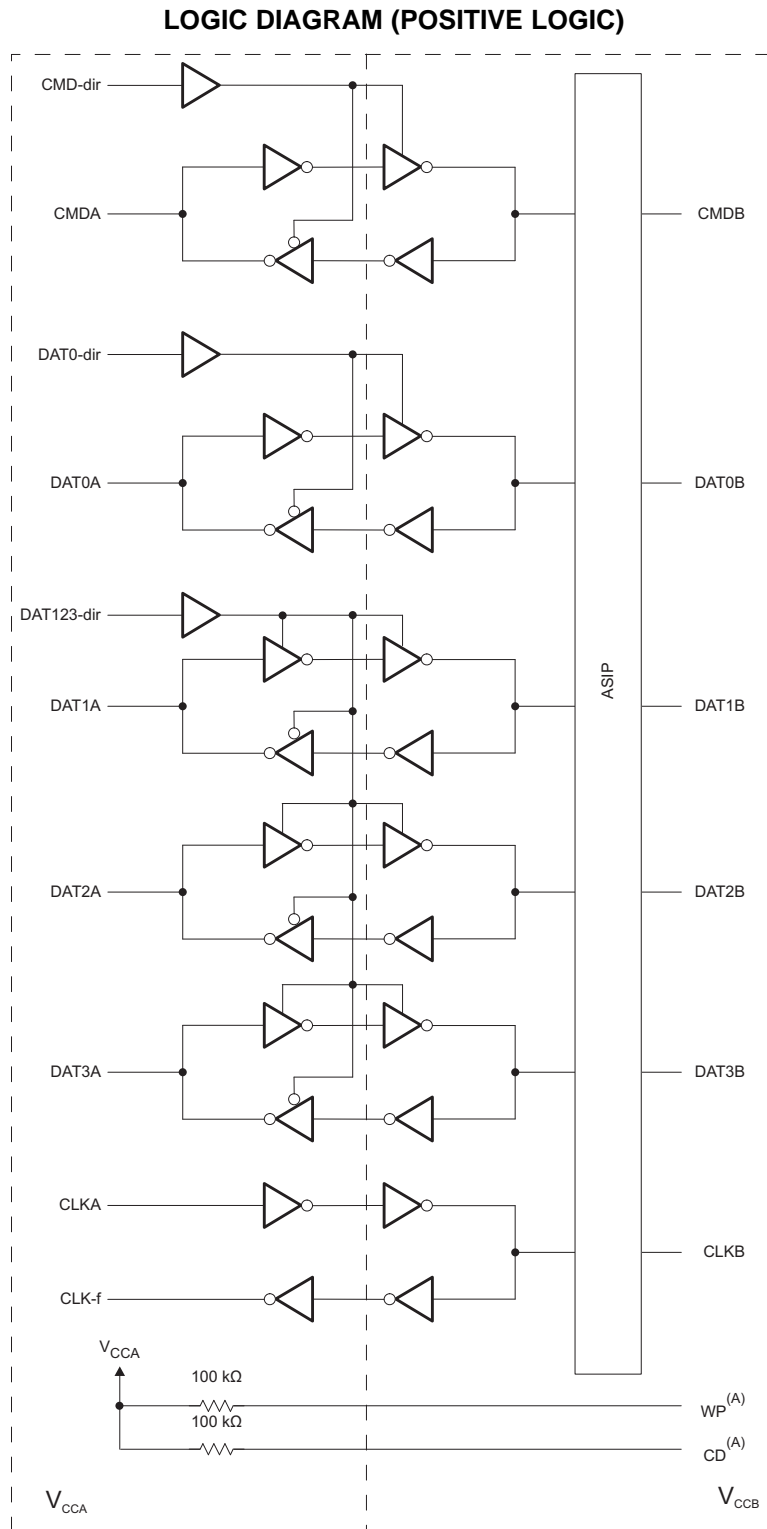
<b>ZQS BALL NO.</b>	<b>ZXY BALL NO.</b>	<b>NAME</b>	<b>FUNCTION</b>	<b>TYPE</b>
A1	B4	DAT2A	Data bit 3 connected to host. Referenced to $V_{CCA}$ .	I/O
A2	B5	CMD-dir	Direction control for command bit (CMDA/CMDB)	Input
A3	C5	DAT0-dir	Direction control for DAT0A/DAT0B	Input
A4, C2	–	RSV	Reserved (for possible future functionality). Leave unconnected.	
A5	C5	DAT2B	Data bit 3 connected to memory card. Includes a 70-k $\Omega$ 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-k $\Omega$ 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-k $\Omega$ pullup resistor to $V_{CCA}$ and this pin has $\pm 10$ -kV Air-Gap Discharge and $\pm 8$ -kV Contact Discharge ESD protection.	Output
D4	C2	CMDB	Command bit connected to memory card. Includes a 15-k $\Omega$ pullup resistor to $V_{CCB}$ .	I/O
D5	D2	DAT0B	Data bit 1 connected to memory card. Includes a 70-k $\Omega$ 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-k $\Omega$ pullup resistor to $V_{CCA}$ and this pin has $\pm 10$ -kV Air-Gap Discharge and $\pm 8$ -kV Contact Discharge ESD protection.	Output
E5	D1	DAT1B	Data bit 2 connected to memory card. Includes a 70-k $\Omega$ 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

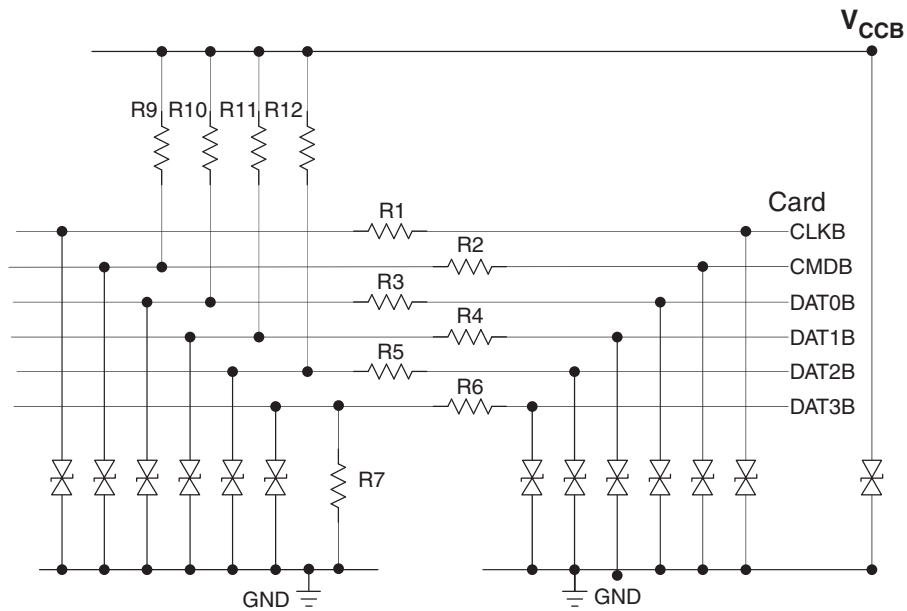
CONTROL INPUT DAT123-dir	OUTPUT CIRCUITS		FUNCTION
	DAT1A, DAT2A, DAT3A	DAT1B, DAT2B, DAT3B	
High	Hi-Z	Enabled	DAT1A to DAT1B
			DAT2A to DAT2B
			DAT3A to DAT3B
Low	Enabled	Hi-Z	DAT1B to DAT1A
			DAT2B to DAT2A
			DAT3B to DAT3A



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

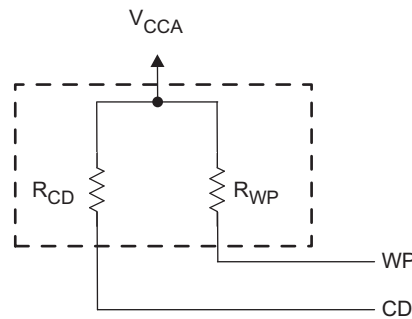
**Figure 2. Logic Diagram**

**BLOCK DIAGRAM**



**Figure 3. ASIP Block Diagram**

RESISTORS		BIDIRECTIONAL ZENER DIODES	
R1, R2, R3, R4, R5, R6	40 $\Omega$	V <sub>br</sub> min.	14 V at 1 mA
Tolerance	$\pm 20\%$	Line capacitance	<20 pF
R10, R11, R12	70 k $\Omega$		
R9	15 k $\Omega$		
R7	470 k $\Omega$		
Tolerance	$\pm 30\%$		



Resistors	
$R_{WP}$ , $R_{CD}$	100 k $\Omega$
Tolerance	$\pm 30\%$

**Figure 4. WP, CD Pullup Resistors (for ZQS Package Only)**

## 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)(3)</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	
$T_{stg}$	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 <sup>(1)</sup>	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**<sup>(1)(2)(3)</sup>

		$V_{CCI}$	$V_{CCO}$	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 <sup>(4)</sup>	1.2 V to 1.95 V	$V_{CCI} \times 0.65$	1.7	V
			1.95 V to 2.7 V			
			2.7 V to 3.6 V			
$V_{IL}$	Low-level input voltage	All inputs <sup>(4)</sup>	1.2 V to 1.95 V	$V_{CCI} \times 0.35$	0.7	V
			1.95 V to 2.7 V			
			2.7 V to 3.6 V			
$V_I$	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	
$\Delta t/\Delta v$	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. 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  $V_{CCA}$ .



**ELECTRICAL CHARACTERISTICS**

 over recommended operating free-air temperature range (unless otherwise noted)<sup>(1)(2)</sup>

PARAMETER		TEST CONDITIONS		V <sub>CCA</sub>	V <sub>CCB</sub>	MIN	TYP <sup>(3)</sup>	MAX	UNIT
V <sub>OH</sub>	A port	I <sub>OH</sub> = -100 μA	V <sub>I</sub> = V <sub>IH</sub>	1.2 V to 3.6 V	1.2 V to 3.6 V	V <sub>CCO</sub> - 0.2		V	
		I <sub>OH</sub> = -1 mA		1.2 V	1.2 V	0.9			
		I <sub>OH</sub> = -1 mA		1.4 V	1.4 V	1.05			
		I <sub>OH</sub> = -2 mA		1.65 V	1.65 V	1.2			
		I <sub>OH</sub> = -4 mA		2.3 V	2.3 V	1.75			
		I <sub>OH</sub> = -8 mA		3 V	3 V	2.3			
V <sub>OL</sub>	A port	I <sub>OL</sub> = 100 μA	V <sub>I</sub> = V <sub>IL</sub>	1.2 V to 3.6 V	1.2 V to 3.6 V	0.2		V	
		I <sub>OL</sub> = 1 mA		1.2 V	1.2 V	0.1			
		I <sub>OL</sub> = 1 mA		1.4 V	1.4 V	0.35			
		I <sub>OL</sub> = 2 mA		1.65 V	1.65 V	0.45			
		I <sub>OL</sub> = 4 mA		2.3 V	2.3 V	0.55			
		I <sub>OL</sub> = 8 mA		3 V	3 V	0.7			
V <sub>OH</sub>	B port	I <sub>OH</sub> = -100 μA	V <sub>I</sub> = V <sub>IH</sub>	1.2 V to 3.6 V	1.2 V to 3.6 V	V <sub>CCO</sub> - 0.2		V	
		I <sub>OH</sub> = -1 mA		1.2 V	1.2 V	1.1			
		I <sub>OH</sub> = -2 mA		1.4 V	1.4 V	1.05			
		I <sub>OH</sub> = -4 mA		1.65 V	1.65 V	1.2			
		I <sub>OH</sub> = -8 mA		2.3 V	2.3 V	1.75			
		I <sub>OH</sub> = -16 mA		3 V	3 V	2.1			
V <sub>OL</sub>	B port	I <sub>OL</sub> = 100 μA	V <sub>I</sub> = V <sub>IL</sub>	1.2 V to 3.6 V	1.2 V to 3.6 V	0.2		V	
		I <sub>OL</sub> = 1 mA		1.2 V	1.2 V	0.07			
		I <sub>OL</sub> = 2 mA		1.4 V	1.4 V	0.35			
		I <sub>OL</sub> = 4 mA		1.65 V	1.65 V	0.45			
		I <sub>OL</sub> = 8 mA		2.3 V	2.3 V	0.55			
		I <sub>OL</sub> = 16 mA		3 V	3 V	0.79			
I <sub>I</sub>	Control inputs	V <sub>I</sub> = V <sub>CCA</sub> or GND		1.2 V to 3.6 V	1.2 V to 3.6 V	±1		μA	
I <sub>OZ</sub> <sup>(4)</sup>	A or B port	V <sub>O</sub> = V <sub>CCO</sub> or GND, V <sub>I</sub> = V <sub>CCI</sub> or GND	See function table for input states when outputs are Hi Z	3.6 V	3.6 V	±5		μA	
I <sub>CCA</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 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 <sub>CCB</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 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 <sub>CCA</sub> + I <sub>CCB</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0		1.2 V to 3.6 V	1.2 V to 3.6 V	15		μA	
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CCA</sub> or GND		1.8 V	3 V	1.5	2	pF	
	Clock input					1.5	2		
C <sub>io</sub>	A port	V <sub>O</sub> = V <sub>CCA</sub> or GND		1.8 V	3 V	2.5	3.5	pF	
	B port	V <sub>O</sub> = V <sub>CCB</sub> or GND				12	14		

 (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 data input port.

 (3) All typical values are at T<sub>A</sub> = 25°C.

 (4) For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

## OUTPUT SLEW RATES

over recommended operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

PARAMETER	FROM	TO	V <sub>CCA</sub> = 1.8 V ± 0.15 V, V <sub>CCB</sub> = 3 V ± 0.3 V		UNIT
			MIN	MAX	
t <sub>r</sub>	20%	80%	2.7 <sup>(2)</sup>		ns
t <sub>f</sub>	80%	20%	2.5 <sup>(2)</sup>		ns

- (1) Values are characterized, but not production tested.  
 (2) Using C<sub>L</sub> = 30 pF on the B side and C<sub>L</sub> = 7 pF on the A side

## TYPICAL SWITCHING CHARACTERISTICS

T<sub>A</sub> = 25°C, V<sub>CCA</sub> = 1.2 V (see Figure 6)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = 1.5 V	V <sub>CCB</sub> = 1.8 V	V <sub>CCB</sub> = 2.5 V	V <sub>CCB</sub> = 3 V	UNIT
			TYP	TYP	TYP	TYP	TYP	
t <sub>pd</sub>	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 <sub>en</sub> <sup>(1)</sup>	DIR	A	5.3	5.4	5.2	6	5.9	ns
t <sub>dis</sub> <sup>(1)</sup>	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<sub>CCA</sub> = 1.5 V ± 0.1 V

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CCB</sub> = 1.5 V ± 0.1 V		V <sub>CCB</sub> = 1.8 V ± 0.15 V		V <sub>CCB</sub> = 2.5 V ± 0.2 V		V <sub>CCB</sub> = 3 V ± 0.3 V		V <sub>CCB</sub> = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>pd</sub>	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 <sub>en</sub> <sup>(1)</sup>	DIR	A	1.0	9.1	1.1	10.3	1.1	8.7	1.1	11	1.1	11	ns
t <sub>dis</sub> <sup>(1)</sup>	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.

**SWITCHING CHARACTERISTICS**

$V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		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**

$V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		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**

$V_{CCA} = 3.3 \text{ V} \pm 0.3 \text{ V}$

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		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

$T_A = 25^\circ\text{C}$ ,  $V_{CCA} = 1.2\text{ V}$  (see [Figure 6](#))

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

## MAXIMUM FREQUENCY AND OUTPUT SKEW

$V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$

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

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

## MAXIMUM FREQUENCY AND OUTPUT SKEW

$V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$

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

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

**MAXIMUM FREQUENCY AND OUTPUT SKEW**

$V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$

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

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

**MAXIMUM FREQUENCY AND OUTPUT SKEW**

$V_{CCA} = 3.3 \text{ V} \pm 0.3 \text{ V}$

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

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

**OPERATING CHARACTERISTICS**

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

PARAMETER		TEST CONDITIONS	$V_{CCA} = V_{CCB} = 1.2 \text{ V}$	$V_{CCA} = V_{CCB} = 1.5 \text{ V}$	$V_{CCA} = V_{CCB} = 1.8 \text{ V}$	$V_{CCA} = V_{CCB} = 2.5 \text{ V}$	$V_{CCA} = V_{CCB} = 3 \text{ V}$	$V_{CCA} = V_{CCB} = 3.3 \text{ V}$	UNIT
			TYP	TYP	TYP	TYP	TYP	TYP	
$C_{\text{pdA}}^{(1)}$	A-port input, B-port output	$C_L = 0$ , $f = 10 \text{ MHz}$ , $t_r = t_f = 1 \text{ ns}$	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	
$C_{\text{pdB}}^{(1)}$	A-port input, B-port output	$C_L = 0$ , $f = 10 \text{ MHz}$ , $t_r = t_f = 1 \text{ ns}$	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

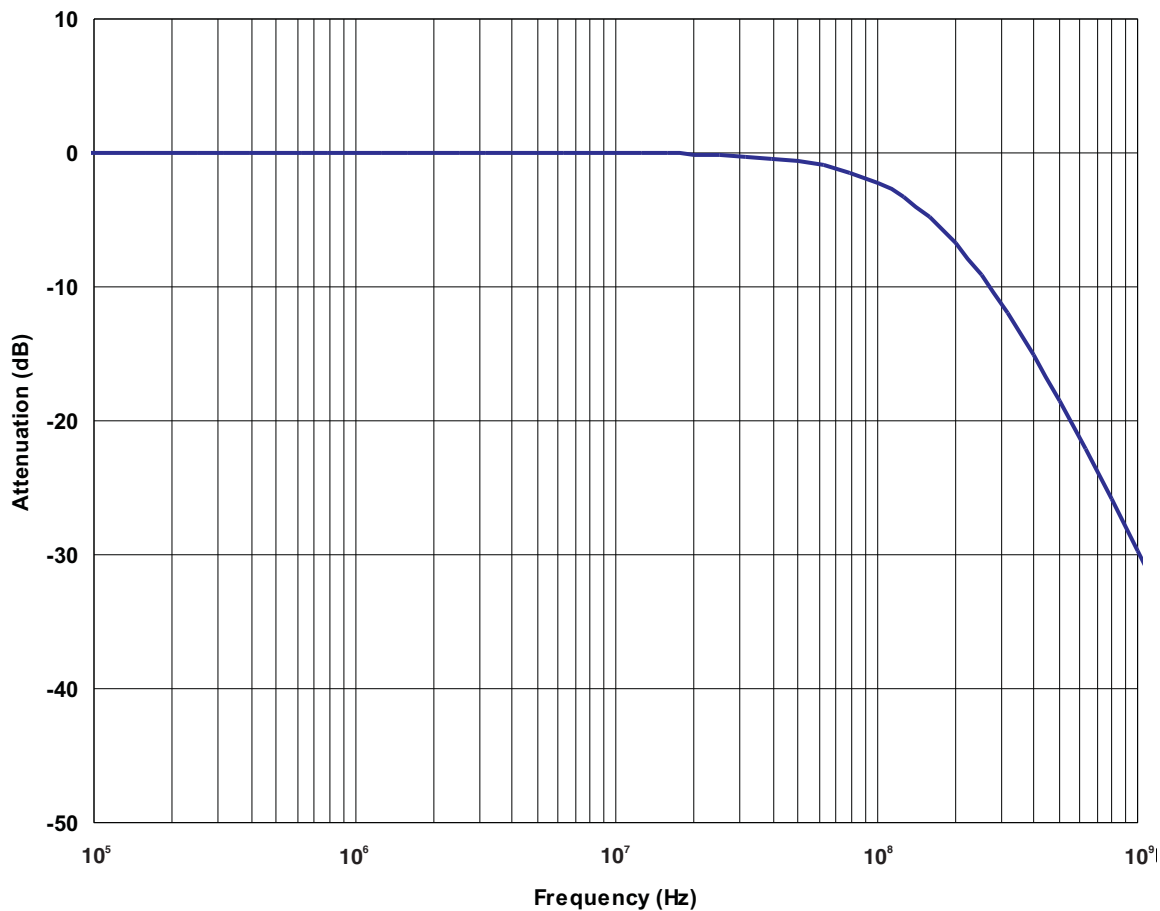
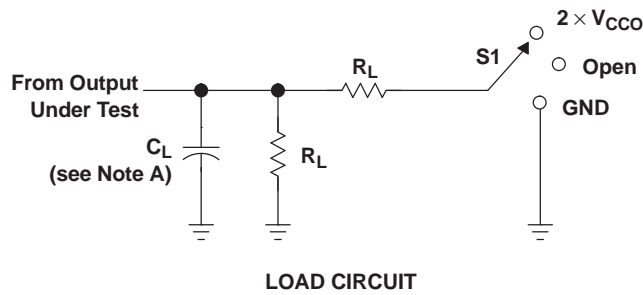


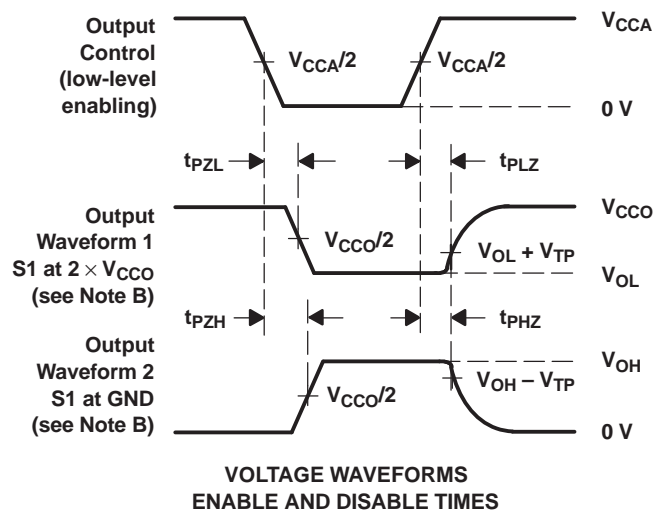
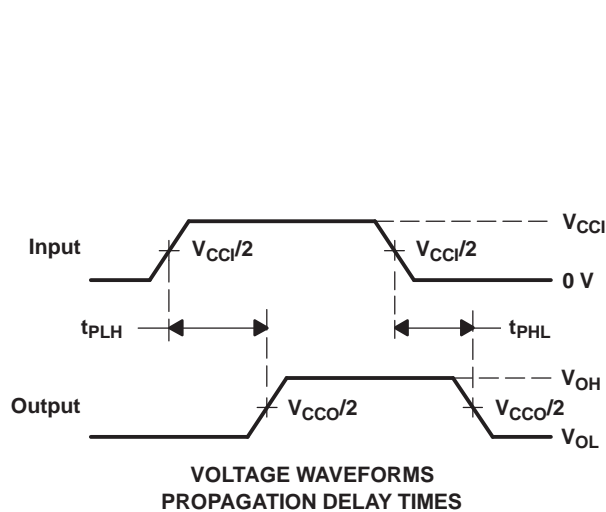
Figure 5. Typical ASIP EMI Filter Frequency Response

PARAMETER MEASUREMENT INFORMATION



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

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



- 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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $dv/dt \geq 1\text{ V/ns}$ .
  - 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

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AVCA406EZQSR	ACTIVE	BGA MICROSTAR JUNIOR	ZQS	24	2500	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	WM406E	<a href="#">Samples</a>
SN74AVCA406EZXYR	ACTIVE	BGA MICROSTAR JUNIOR	ZXY	20	2500	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	WM406E	<a href="#">Samples</a>

(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.

(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.

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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
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**

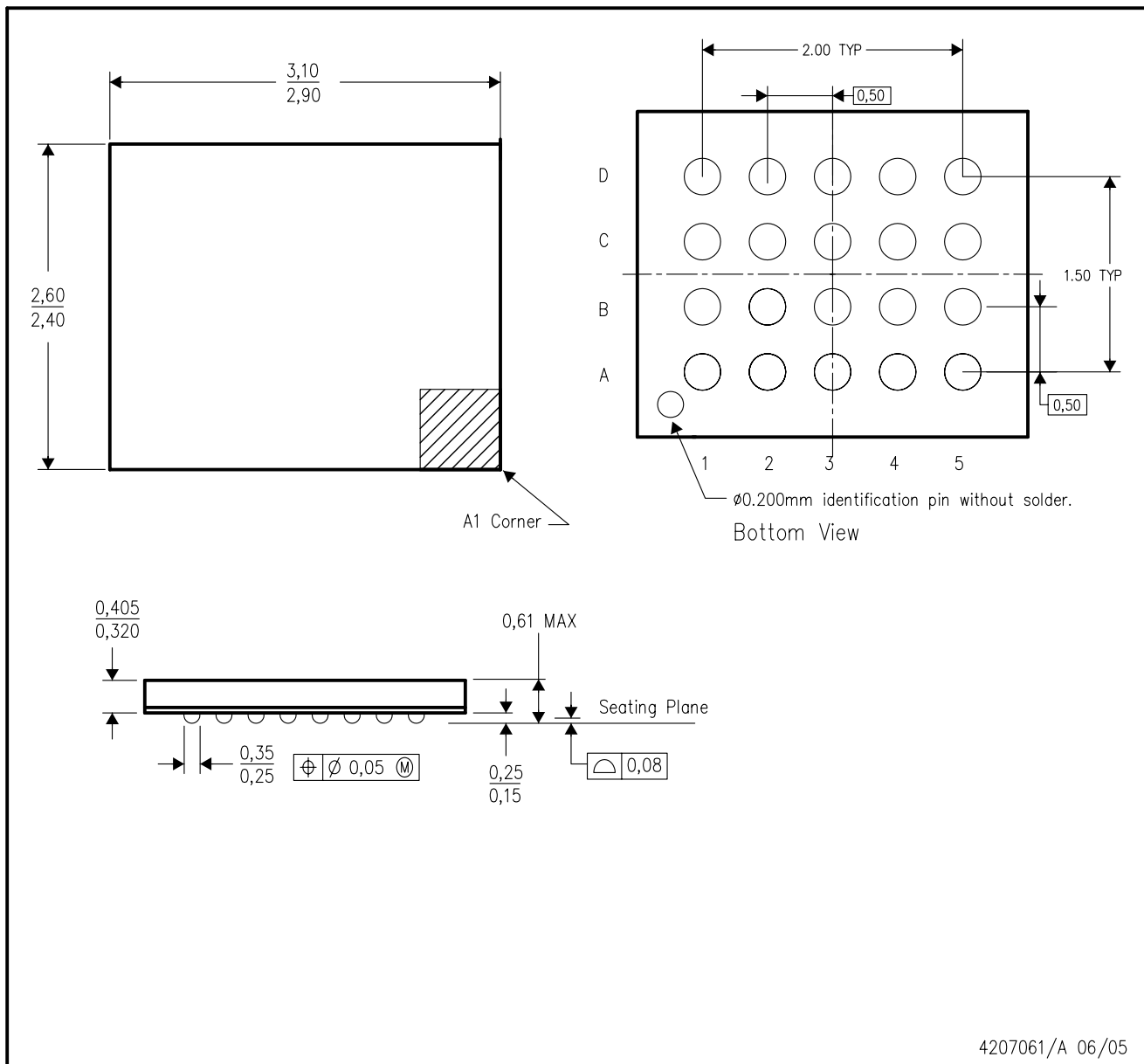


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVCA406EZQSR	BGA MICROSTAR JUNIOR	ZQS	24	2500	336.6	336.6	28.6
SN74AVCA406EZXYR	BGA MICROSTAR JUNIOR	ZXY	20	2500	336.6	336.6	28.6

ZXY (S-PBGA-N20)

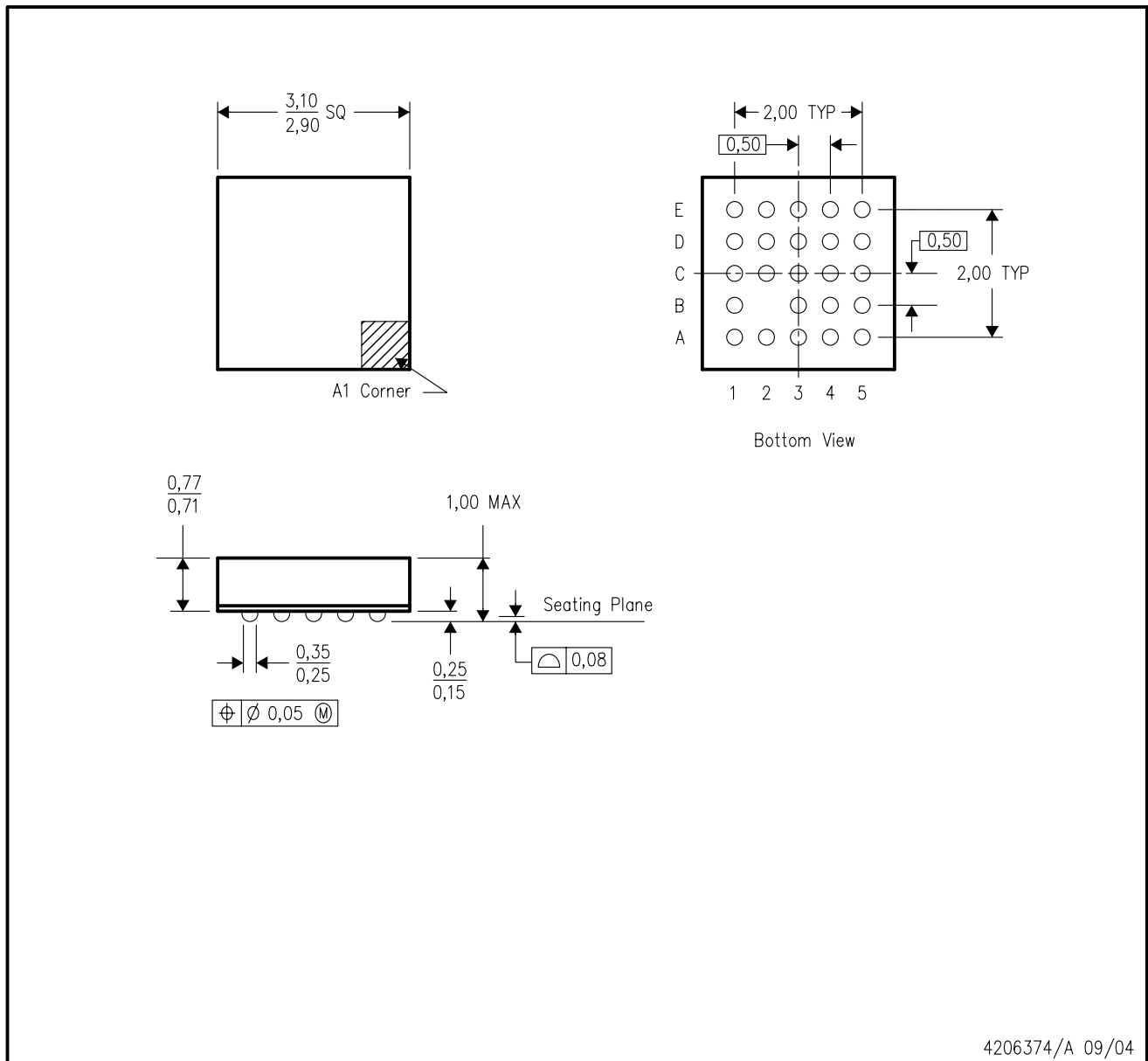
PLASTIC BALL GRID ARRAY



- 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.

ZQS (S-PBGA-N24)

PLASTIC BALL GRID ARRAY



- 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.

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