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.

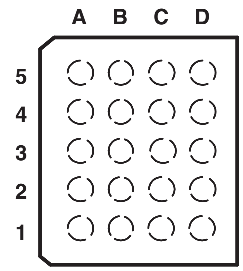
The SN74AVCA406E is available in two 0.5-mm-pitch ball grid array (BGA) packages. The 20-ball package has dimensions of 3 mm × 2.5 mm, and the 24-ball package measures 3 mm × 3 mm. Memory cards are widely used in mobile phones, PDAs, digital cameras, personal media players, camcorders, set-top boxes, 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.

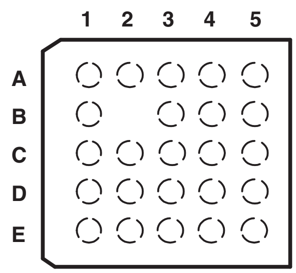
ZXY PACKAGE
(TOP VIEW)



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

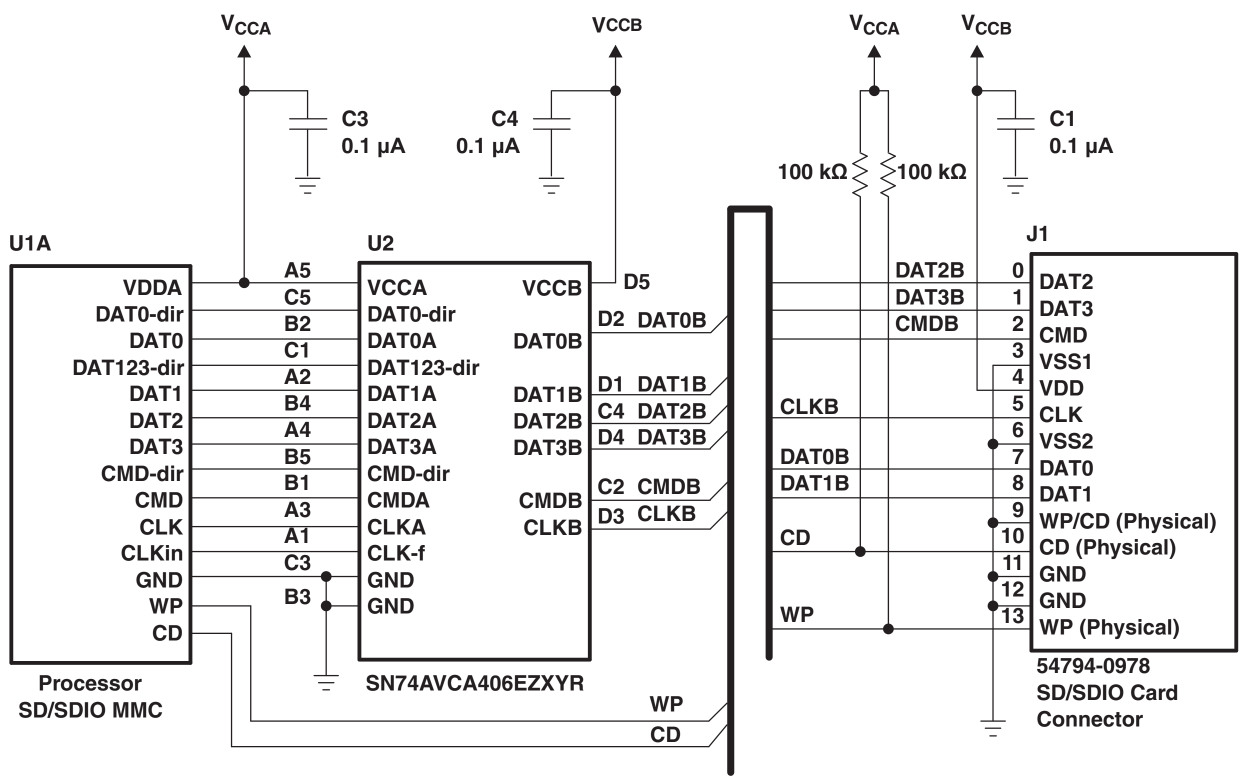


Figure 1. Interfacing With SD/SDIO Card

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

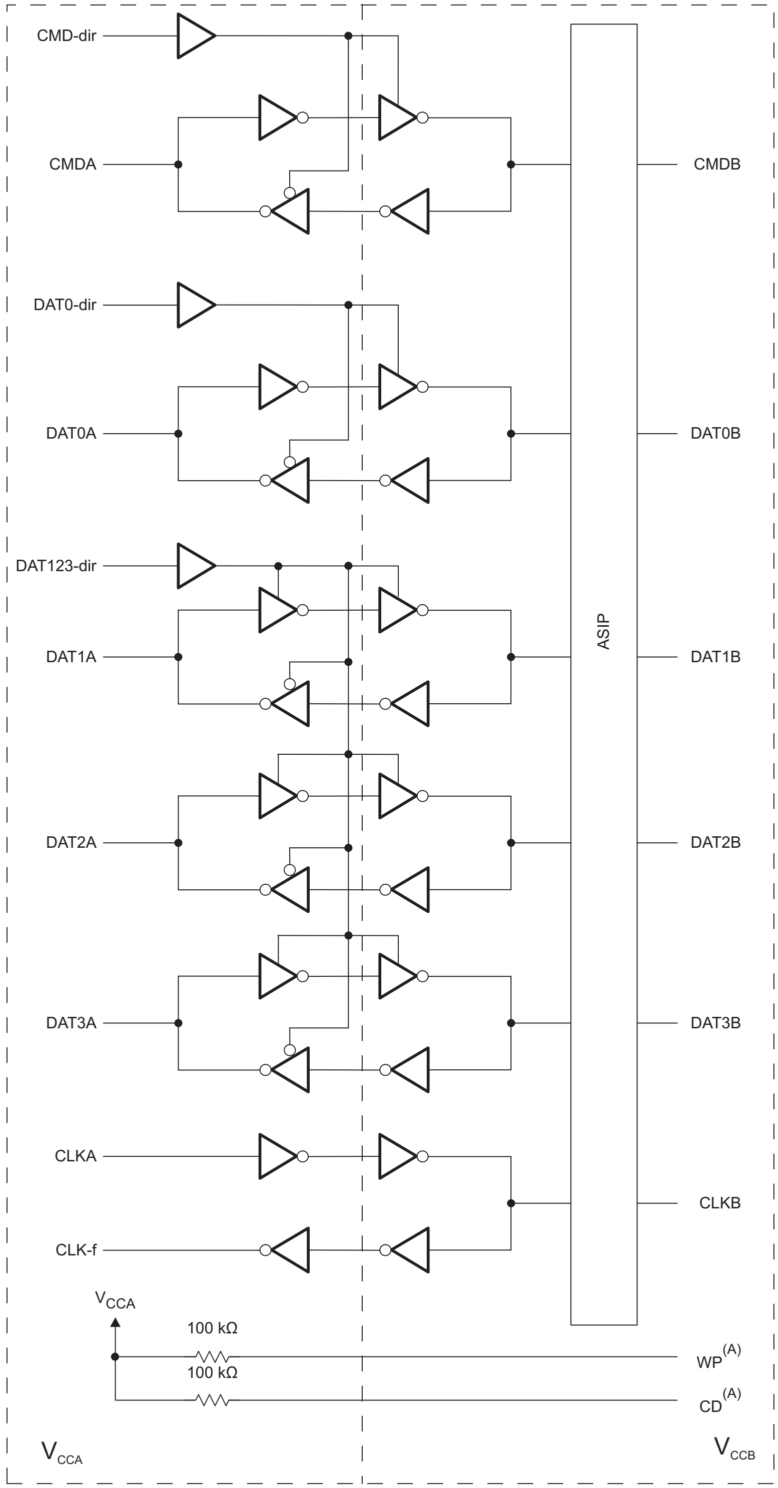
FUNCTION TABLES

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
			DAT2A to DAT2B
			DAT3A to DAT3B
Low	Enabled	Hi-Z	DAT1B to DAT1A
			DAT2B to DAT2A
			DAT3B to DAT3A

LOGIC DIAGRAM (POSITIVE LOGIC)



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

Figure 2. Logic Diagram

BLOCK DIAGRAM

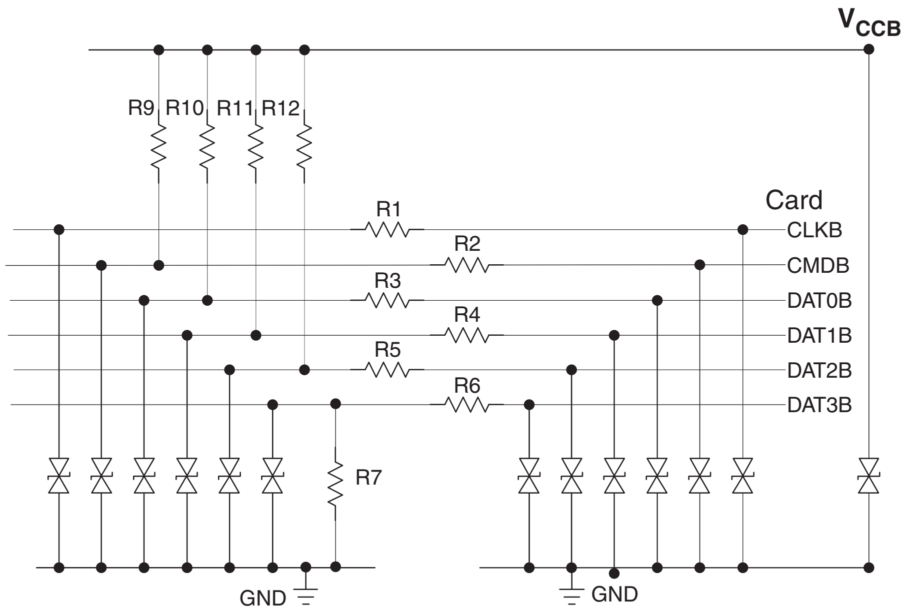
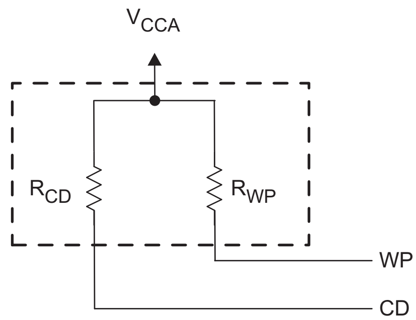


Figure 3. ASIP Block Diagram

RESISTORS		BIDIRECTIONAL ZENER DIODES	
R1, R2, R3, R4, R5, R6	40 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)

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
θ_{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	
$\Delta t/\Delta v$	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)[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.

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

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

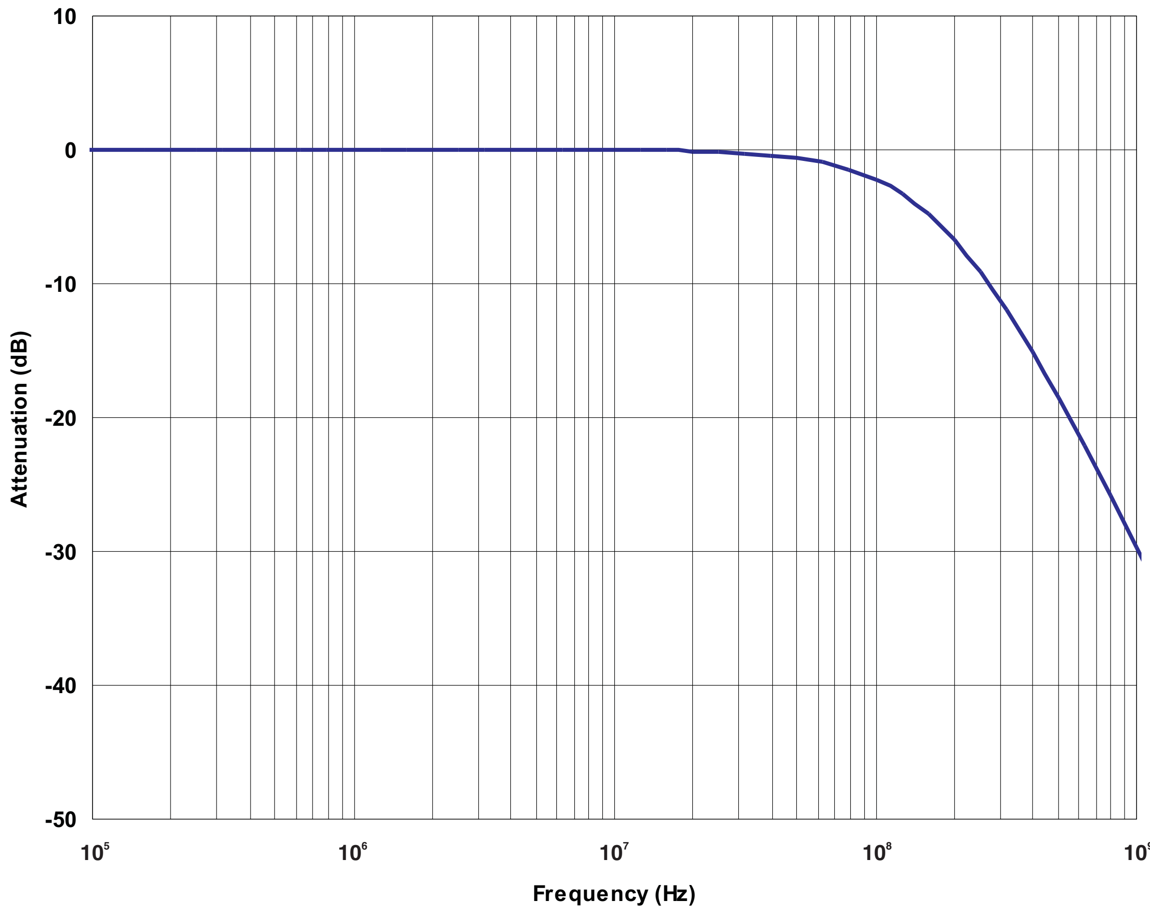
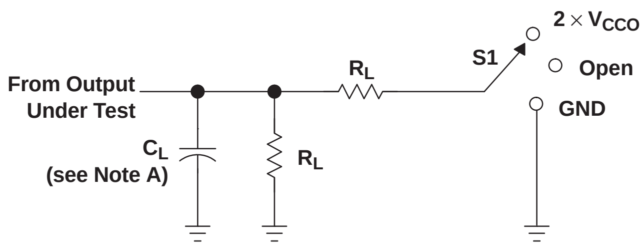


Figure 5. Typical ASIP EMI Filter Frequency Response

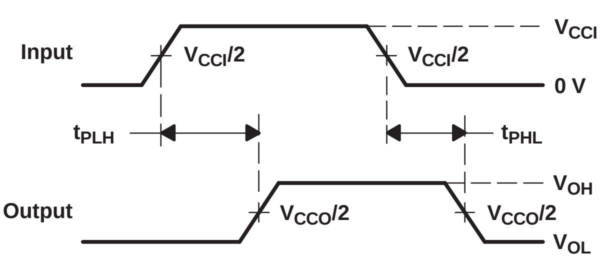
PARAMETER MEASUREMENT INFORMATION



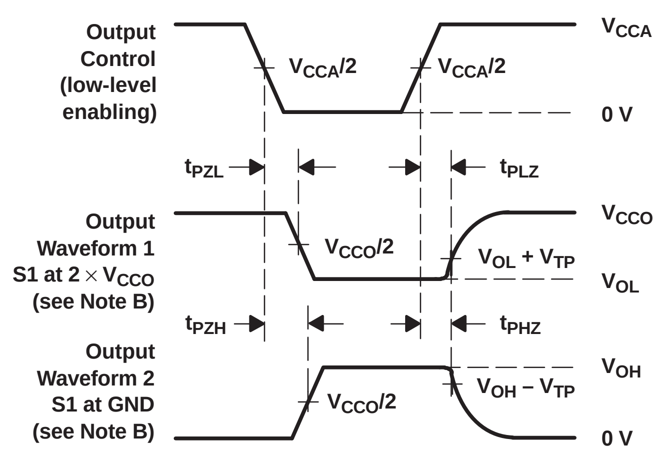
LOAD CIRCUIT

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 ± 0.1 V	15 pF	2 kΩ	0.1 V
1.8 V ± 0.15 V	15 pF	2 kΩ	0.15 V
2.5 V ± 0.2 V	15 pF	2 kΩ	0.15 V
3.3 V ± 0.3 V	15 pF	2 kΩ	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 ≤ 10 MHz, Z_O = 50 Ω, dv/dt ≥ 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

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	Samples
SN74AVCA406EZXYR	ACTIVE	BGA MICROSTAR JUNIOR	ZXY	20	2500	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	WM406E	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.
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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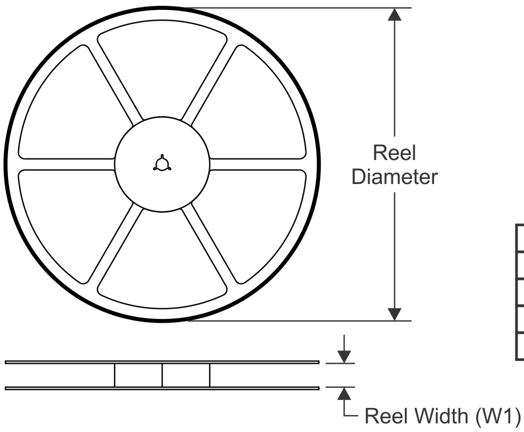
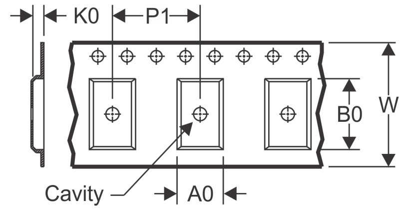
TAPE AND REEL INFORMATION

REEL DIMENSIONS

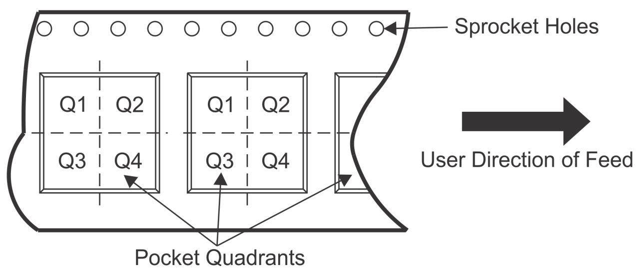


TAPE DIMENSIONS



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

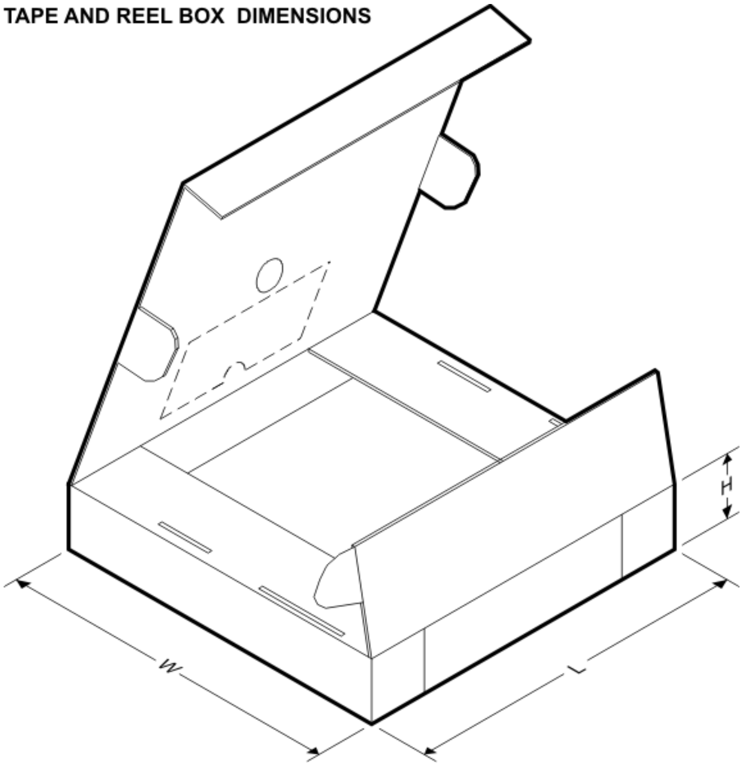
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 MI CROSTA R JUNI OR	ZQS	24	2500	330.0	12.4	3.3	3.3	1.6	8.0	12.0	Q1
SN74AVCA406EZXYR	BGA MI CROSTA R JUNI OR	ZXY	20	2500	330.0	12.4	2.8	3.3	1.0	4.0	12.0	Q2

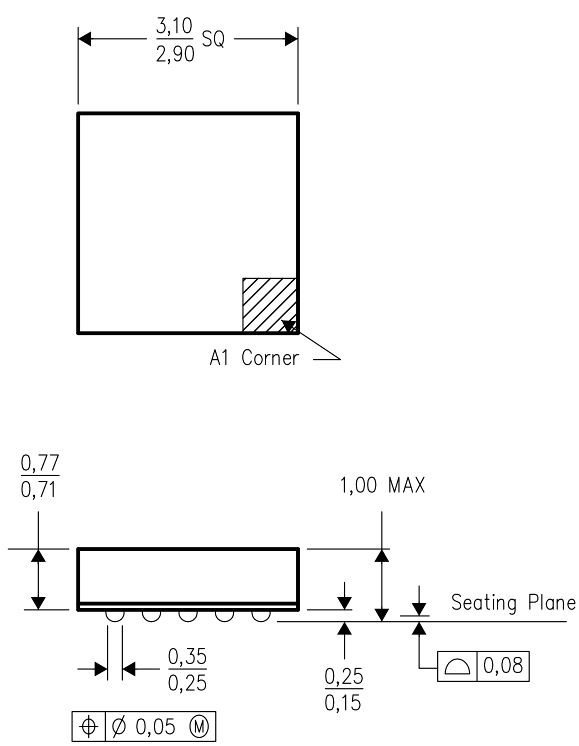
TAPE AND REEL BOX DIMENSIONS



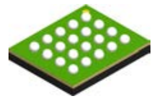
*All dimensions are nominal

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

ZQS (S–PBGA–N24) PLASTIC BALL GRID ARRAY



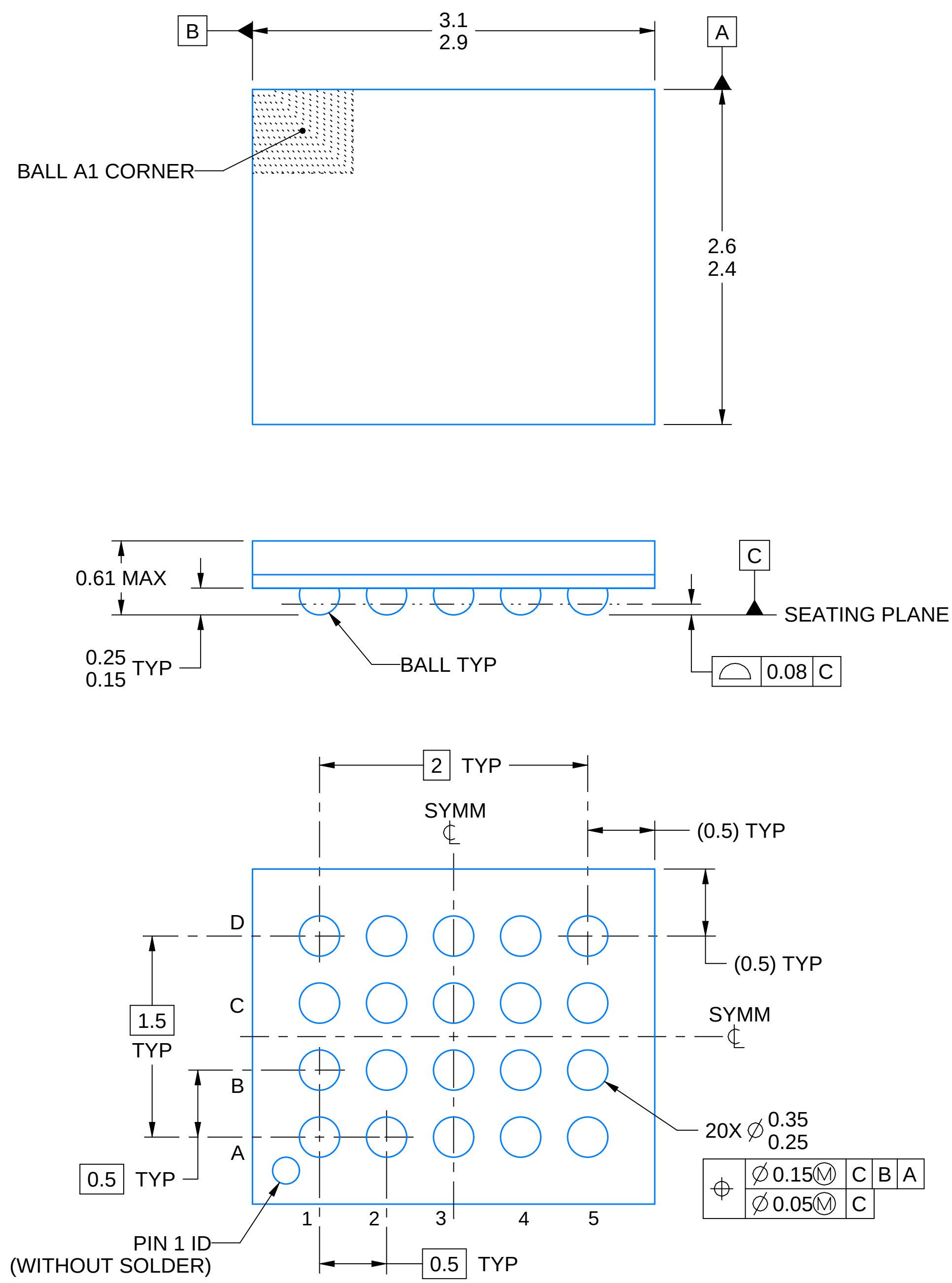
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO–225
D. This package is lead–free.



ZXY0020A

VFBGA - 0.61 mm max height

PLASTIC BALL GRID ARRAY



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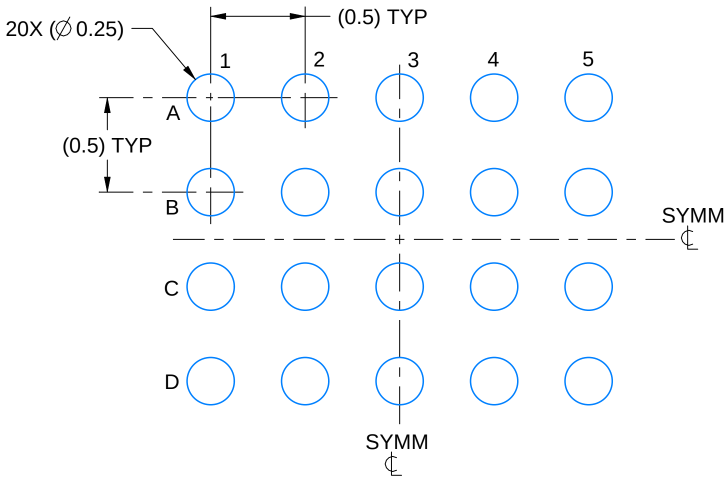
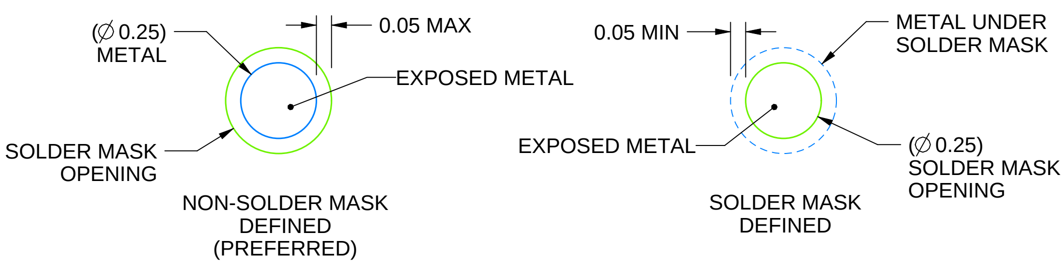
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:25X



SOLDER MASK DETAILS
NOT TO SCALE

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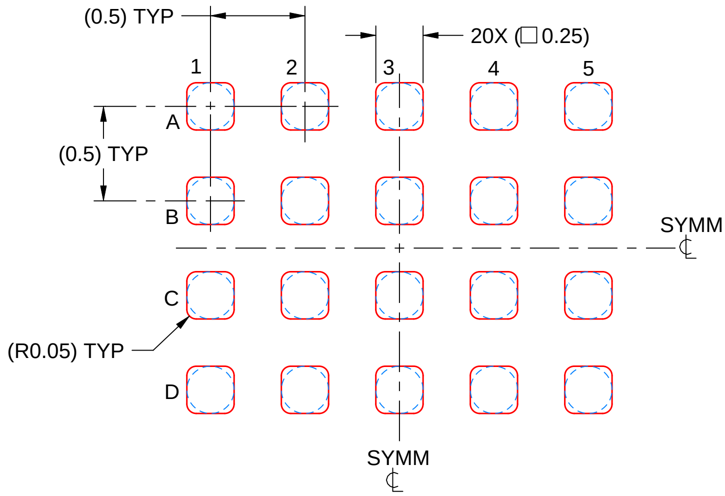
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For information, see Texas Instruments literature number SPRAA99 (www.ti.com/lit/spraa99).



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE: 25X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.