

具有可配置电压转换、电平转换和{1}三态输出的 SN74AVC32T245 32 位双电源总线收发器

1 特性

- 德州仪器 (TI) Widebus+™ 系列产品
- 控制输入电平 V_{IH}/V_{IL} 以 V_{CCA} 电压为基准
- V_{CC} 隔离特性 - 如果任何一个 V_{CC} 输入接地 (GND), 则两个端口均处于高阻抗状态
- 过压耐受输入/输出可实现混合电压模式数据通信
- 完全可配置的双轨设计, 支持各个端口在 1.2V 至 3.6V 的整个电源电压范围内运行
- I_{off} 支持局部断电模式运行
- 可耐受 4.6V 电压的 I/O
- 最大数据速率
 - 380Mbps (1.8V 至 3.3V 电平转换)
 - 200Mbps (低于 1.8V 至 3.3V 电平转换)
 - 200Mbps (转换至 2.5V 或 1.8V)
 - 150Mbps (转换至 1.5V)
 - 100Mbps (转换至 1.2V)
- 闩锁性能超过 100mA, 符合 JESD 78 II 类规范的要求
- ESD 保护性能超过 JESD 22 规范要求
 - 4000V 人体放电模式 (A114-A)
 - 1000V 充电器件模型 (C101)

2 应用

- 个人电子产品
- 工业
- 企业
- 电信

3 说明

这款 32 位同相总线收发器使用两个独立的可配置电源轨。SN74AVC32T245 器件经过优化, 可在 V_{CCA}/V_{CCB} 设置为 1.4V 至 3.6V 的范围内正常运行。该器件可在 V_{CCA}/V_{CCB} 低至 1.2V 时正常运行。A 端口旨在跟踪 V_{CCA} 。 V_{CCA} 可接受 1.2V 至 3.6V 范围内的任一电源电压。B 端口旨在跟踪 V_{CCB} 。 V_{CCB} 可接受 1.2V 至 3.6V 范围内的任一电源电压, 因此可在 1.2V、1.5V、1.8V、2.5V 和 3.3V 电压节点之间任意进行通用低压双向转换。

SN74AVC32T245 旨在实现数据总线间的异步通信。根据方向控制 (DIR) 输入上的逻辑电平, 此器件将数据从 A 总线发送至 B 总线, 或者将数据从 B 总线发送至 A 总线。输出使能 ($\overline{OE}$ 输入可以禁用输出, 从而有效隔离总线。

SN74AVC32T245 被设计为控制引脚 (1DIR、2DIR、3DIR、4DIR、1 $\overline{OE}$ 、2 $\overline{OE}$ 、3 $\overline{OE}$ 和 4 $\overline{OE}$) 由 V_{CCA} 供电。

器件信息

器件型号	封装 ⁽¹⁾	封装尺寸 (标称值)
SN74AVC32T245ZKE/GKE	LFBGA (96)	13.50mm × 5.50mm
SN74AVC32T245ZRL	BGA MICROSTAR JUNIOR (96)	8.50mm × 3.50mm
SN74AVC32T245NMJ	nFBGA (96)	13.50mm × 5.50mm

(1) 如需了解所有可用封装, 请参阅产品说明书末尾的可订购产品附录。

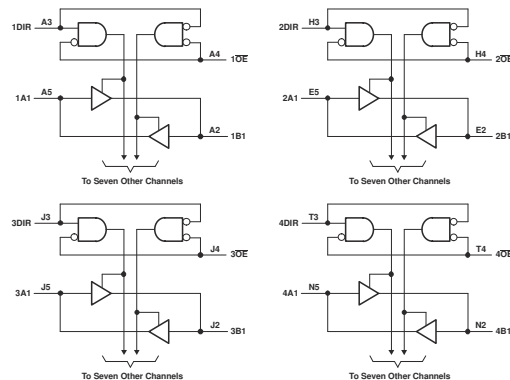


图 3-1. 逻辑图



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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision G (July 2020) to Revision H (November 2020)	Page
• 更新了整个文档的表、图和交叉参考的编号格式.....	1
• 将器件信息表中的 SN74AVC32T245NMJ nFBGA (96) 封装尺寸从 8.50mm × 3.50mm 更改为 13.50mm × 5.50mm.....	1

Changes from Revision F (July 2015) to Revision G (July 2020)	Page
• 向器件信息表添加了 NMJ 封装选项.....	1
• Added NMJ package pinout drawing.....	4
• Added NMJ package option to <i>Thermal Information</i> table.....	8

Changes from Revision E (August 2007) to Revision F (July 2015)	Page
• 添加了引脚配置和功能部分、ESD 等级表、特性说明部分、器件功能模式、应用和实施部分、电源相关建议部分、布局部分、器件和文档支持部分以及机械、封装和可订购信息部分.....	1

5 Description (continued)

This device is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

The V_{CC} isolation feature ensures that if either V_{CC} input is at GND, then both ports are in the high-impedance state.

To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

6 Pin Configuration and Functions

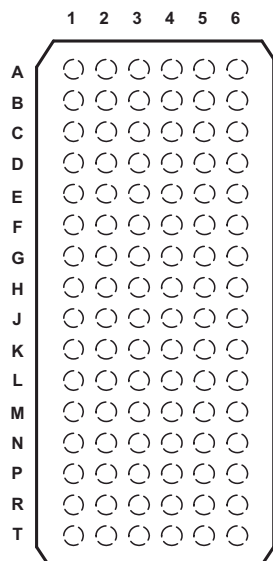


图 6-1. GKE, ZKE Package 96-Pin LFBGA Top View

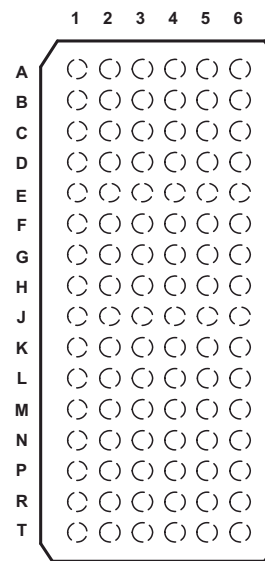


图 6-2. ZRL Package 96-Pin BGA MICROSTAR JUNIOR Top View

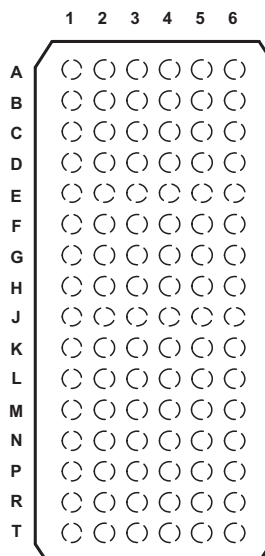


图 6-3. NMJ Package 96-Pin nFBGA Top View

表 6-1. Pin Assignments

	1	2	3	4	5	6
A	1B2	1B1	1DIR	1 $\overline{OE}$	1A1	1A2
B	1B4	1B3	GND	GND	1A3	1A4
C	1B6	1B5	V _{CCB}	V _{CCA}	1A5	1A6
D	1B8	1B7	GND	GND	1A7	1A8
E	2B2	2B1	GND	GND	2A1	2A2
F	2B4	2B3	V _{CCB}	V _{CCA}	2A3	2A4
G	2B6	2B5	GND	GND	2A5	2A6
H	2B7	2B8	2DIR	2 $\overline{OE}$	2A8	2A7

表 6-1. Pin Assignments (continued)

	1	2	3	4	5	6
J	3B2	3B1	3DIR	3 OE	3A1	3A2
K	3B4	3B3	GND	GND	3A3	3A4
L	3B6	3B5	V _{CCB}	V _{CCA}	3A5	3A6
M	3B8	3B7	GND	GND	3A7	3A8
N	4B2	4B1	GND	GND	4A1	4A2
P	4B4	4B3	V _{CCB}	V _{CCA}	4A3	4A4
R	4B6	4B5	GND	GND	4A5	4A6
T	4B7	4B8	4DIR	4 OE	4A8	4A7

表 6-2. Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
A1	1B2	Input/Output	Referenced to V _{CCB}
A2	1B1	Input/Output	Referenced to V _{CCB}
A3	1DIR	Input	Direction-control signal
A4	1 OE	Input	Tri-State output-mode enables. Pull OE high to place all outputs in Tri-State mode. Referenced to V _{CCA}
A5	1A1	Input/Output	Referenced to V _{CCA}
A6	1A2	Input/Output	Referenced to V _{CCA}
B1	1B4	Input/Output	Referenced to V _{CCB}
B2	1B3	Input/Output	Referenced to V _{CCB}
B3	GND	—	Ground
B4	GND	—	Ground
B5	1A3	Input/Output	Referenced to V _{CCA}
B6	1A4	Input/Output	Referenced to V _{CCA}
C1	1B6	Input/Output	Referenced to V _{CCB}
C2	1B5	Input/Output	Referenced to V _{CCB}
C3	V _{CCB}	—	B-port supply voltage. 1.2 V ≤ V _{CCB} ≤ 3.6 V
C4	V _{CCA}	—	A-port supply voltage. 1.2 V ≤ V _{CCA} ≤ 3.6 V
C5	1A5	Input/Output	Referenced to V _{CCA}
C6	1A6	Input/Output	Referenced to V _{CCA}
D1	1B8	Input/Output	Referenced to V _{CCB}
D2	1B7	Input/Output	Referenced to V _{CCB}
D3	GND	—	Ground
D4	GND	—	Ground
D5	1A7	Input/Output	Referenced to V _{CCA}
D6	1A8	Input/Output	Referenced to V _{CCA}
E1	2B2	Input/Output	Referenced to V _{CCB}
E2	2B1	Input/Output	Referenced to V _{CCB}
E3	GND	—	Ground
E4	GND	—	Ground
E5	2A1	Input/Output	Referenced to V _{CCA}
E6	2A2	Input/Output	Referenced to V _{CCA}
F1	2B4	Input/Output	Referenced to V _{CCB}
F2	2B3	Input/Output	Referenced to V _{CCB}
F3	V _{CCB}	—	B-port supply voltage. 1.2 V ≤ V _{CCB} ≤ 3.6 V

表 6-2. Pin Functions (continued)

PIN		I/O	DESCRIPTION
NO.	NAME		
F4	V _{CCA}	—	A-port supply voltage. $1.2\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$
F5	2A3	Input/Output	Referenced to V _{CCA}
F6	2A4	Input/Output	Referenced to V _{CCA}
G1	2B6	Input/Output	Referenced to V _{CCB}
G2	2B5	Input/Output	Referenced to V _{CCB}
G3	GND	—	Ground
G4	GND	—	Ground
G5	2A5	Input/Output	Referenced to V _{CCA}
G6	2A6	Input/Output	Referenced to V _{CCA}
H1	2B7	Input/Output	Referenced to V _{CCB}
H2	2B8	Input/Output	Referenced to V _{CCB}
H3	2DIR	Input	Direction-control signal
H4	2 $\overline{\text{OE}}$	Input	Tri-State output-mode enables. Pull $\overline{\text{OE}}$ high to place all outputs in Tri-State mode. Referenced to V _{CCA}
H5	2A8	Input/Output	Referenced to V _{CCA}
H6	2A7	Input/Output	Referenced to V _{CCA}
J1	3B2	Input/Output	Referenced to V _{CCB}
J2	3B1	Input/Output	Referenced to V _{CCB}
J3	3DIR	Input	Direction-control signal
J4	3 $\overline{\text{OE}}$	Input	Tri-State output-mode enables. Pull $\overline{\text{OE}}$ high to place all outputs in Tri-State mode. Referenced to V _{CCA}
J5	3A1	Input/Output	Referenced to V _{CCA}
J6	3A2	Input/Output	Referenced to V _{CCA}
K1	3B4	Input/Output	Referenced to V _{CCB}
K2	3B3	Input/Output	Referenced to V _{CCB}
K3	GND	—	Ground
K4	GND	—	Ground
K5	3A3	Input/Output	Referenced to V _{CCA}
K6	3A4	Input/Output	Referenced to V _{CCA}
L1	3B6	Input/Output	Referenced to V _{CCB}
L2	3B5	Input/Output	Referenced to V _{CCB}
L3	V _{CCB}	—	B-port supply voltage. $1.2\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$
L4	V _{CCA}	—	A-port supply voltage. $1.2\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$
L5	3A5	Input/Output	Referenced to V _{CCA}
L6	3A6	Input/Output	Referenced to V _{CCA}
M1	3B8	Input/Output	Referenced to V _{CCB}
M2	3B7	Input/Output	Referenced to V _{CCB}
M3	GND	—	Ground
M4	GND	—	Ground
M5	3A7	Input/Output	Referenced to V _{CCA}
M6	3A8	Input/Output	Referenced to V _{CCA}
N1	4B2	Input/Output	Referenced to V _{CCB}
N2	4B1	Input/Output	Referenced to V _{CCB}
N3	GND	—	Ground
N4	GND	—	Ground

表 6-2. Pin Functions (continued)

PIN		I/O	DESCRIPTION
NO.	NAME		
N5	4A1	Input/Output	Referenced to V_{CCA}
N6	4A2	Input/Output	Referenced to V_{CCA}
P1	4B4	Input/Output	Referenced to V_{CCB}
P2	4B3	Input/Output	Referenced to V_{CCB}
P3	V_{CCB}	—	A-port supply voltage. $1.2\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$
P4	V_{CCA}	—	A-port supply voltage. $1.2\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$
P5	4A3	Input/Output	Referenced to V_{CCA}
P6	4A4	Input/Output	Referenced to V_{CCA}
R1	4B6	Input/Output	Referenced to V_{CCB}
R2	4B5	Input/Output	Referenced to V_{CCB}
R3	GND	—	Ground
R4	GND	—	Ground
R5	4A5	Input/Output	Referenced to V_{CCA}
R6	4A6	Input/Output	Referenced to V_{CCA}
T1	4B7	Input/Output	Referenced to V_{CCB}
T2	4B8	Input/Output	Referenced to V_{CCB}
T3	4DIR	Input	Direction-control signal
T4	4 $\overline{OE}$	Input	Tri-State output-mode enables. Pull $\overline{OE}$ high to place all outputs in Tri-State mode. Referenced to V_{CCA}
T5	4A8	Input/Output	Referenced to V_{CCA}
T6	4A7	Input/Output	Referenced to V_{CCA}

7 Specifications

7.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CCA} V_{CCB}	Supply voltage		- 0.5	4.6	V
V_I	Input voltage ⁽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 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 each V_{CCA} , V_{CCB} , and GND			±100	mA
T_{stg}	Storage temperature		- 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.

7.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±8000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000

- (1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

7.3 Thermal Information

THERMAL METRIC ⁽¹⁾		SN74AVC32T245			UNIT
		GKE/ZKE (LFBGA)	ZRL (MICROSTAR JUNIOR)	NMJ (nFBGA)	
		96 PINS	96 PINS	96 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	70.7	105.8	26.7	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	34.0	1.6	14.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	43.5	10.8	10.7	°C/W
ψ_{JT}	Junction-to-top characterization parameter	3.5	3.1	1.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter	43.5	10.8	10.5	°C/W

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

7.4 Recommended Operating Conditions

See (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	Data inputs ⁽⁴⁾	1.2 V to 1.95 V		V _{CCI} × 0.65		V
			1.95 V to 2.7 V		1.6		
			2.7 V to 3.6 V		2		
V _{IL}	Low-level input voltage	Data inputs ⁽⁴⁾	1.2 V to 1.95 V		V _{CCI} × 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 (referenced to V _{CCA}) ⁽⁵⁾	1.2 V to 1.95 V		V _{CCA} × 0.65		V
			1.95 V to 2.7 V		1.6		
			2.7 V to 3.6 V		2		
V _{IL}	Low-level input voltage	DIR (referenced to V _{CCA}) ⁽⁵⁾	1.2 V to 1.95 V		V _{CCA} × 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				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			1.2 V		– 3	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			1.2 V		3	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	
Δ t / Δ 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 data 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) For V_{CCI} values not specified in the data sheet, V_{IH} min = V_{CCI} × 0.7 V, V_{IL} max = V_{CCI} × 0.3 V.

(5) For V_{CCI} values not specified in the data sheet, V_{IH} min = V_{CCA} × 0.7 V, V_{IL} max = V_{CCA} × 0.3 V.

7.5 Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)^{(2) (3)}

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	V _I = V _{IH}	1.2 V to 3.6 V	1.2 V to 3.6 V				V _{CCO} – 0.2 V		V
		I _{OH} = – 3 mA		1.2 V	1.2 V		0.95				
		I _{OH} = – 6 mA		1.4 V	1.4 V				1.05		
		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	V _I = V _{IL}	1.2 V to 3.6 V	1.2 V to 3.6 V				0.2		V
		I _{OL} = 3 mA		1.2 V	1.2 V		0.15				
		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		1.2 V to 3.6 V	1.2 V to 3.6 V		±0.025	±0.25		±1	μA
I _{off}	A or B port	V _I or V _O = 0 to 3.6 V		0 V	0 to 3.6 V		±0.1	±2.5		±5	μA
	A or B port			0 to 3.6 V	0 V		±0.1	±2.5		±5	
I _{OZ} ⁽¹⁾	A or B port	V _O = V _{CCO} or GND, V _I = V _{CCI} or GND, OE = V _{IH}		3.6 V	3.6 V		±0.5	±2.5		±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					50	μA	
			0 V	3.6 V				– 10			
			3.6 V	0 V				50			
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					50	μA	
			0 V	3.6 V				50			
			3.6 V	0 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				90	μA	
C _i	Control inputs	V _I = 3.3 V or GND		3.3 V	3.3 V		3.5				pF
C _{io}	A or B port	V _O = 3.3 V or GND		3.3 V	3.3 V		7				pF

(1) For I/O ports, the parameter I_{OZ} includes the input leakage current.

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

(3) V_{CCI} is the V_{CC} associated with the input port.

7.6 Switching Characteristics: $V_{CCA} = 1.2\text{ V}$

over recommended operating free-air temperature range, $V_{CCA} = 1.2\text{ V}$ (see 图 8-1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2\text{ V}$	$V_{CCB} = 1.5\text{ V}$	$V_{CCB} = 1.8\text{ V}$	$V_{CCB} = 2.5\text{ V}$	$V_{CCB} = 3.3\text{ V}$	UNIT
			TYP	TYP	TYP	TYP	TYP	
t_{PLH}	A	B	4.1	3.3	3	2.8	3.2	ns
t_{PHL}			4.1	3.3	3	2.8	3.2	
t_{PLH}	B	A	4.4	4	3.8	3.6	3.5	ns
t_{PHL}			4.4	4	3.8	3.6	3.5	
t_{PZH}	$\overline{OE}$	A	6.4	6.4	6.4	6.4	6.4	ns
t_{PZL}			6.4	6.4	6.4	6.4	6.4	
t_{PZH}	$\overline{OE}$	B	6	4.6	4	3.4	3.2	ns
t_{PZL}			6	4.6	4	3.4	3.2	
t_{PHZ}	$\overline{OE}$	A	6.6	6.6	6.6	6.6	6.8	ns
t_{PLZ}			6.6	6.6	6.6	6.6	6.8	
t_{PHZ}	$\overline{OE}$	B	6	4.9	4.9	4.2	5.3	ns
t_{PLZ}			6	4.9	4.9	4.2	5.3	

7.7 Switching Characteristics: $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$

over recommended operating free-air temperature range, $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$ (see 图 8-1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2\text{ V}$	$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$		$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$		$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	3.6	0.5	6.2	0.5	5.2	0.5	4.1	0.5	3.7	ns
t_{PHL}			3.6	0.5	6.2	0.5	5.2	0.5	4.1	0.5	3.7	
t_{PLH}	B	A	3.3	0.5	6.2	0.5	5.9	0.5	5.6	0.5	5.5	ns
t_{PHL}			3.3	0.5	6.2	0.5	5.9	0.5	5.6	0.5	5.5	
t_{PZH}	$\overline{OE}$	A	4.3	1	10.1	1	10.1	1	10.1	1	10.1	ns
t_{PZL}			4.3	1	10.1	1	10.1	1	10.1	1	10.1	
t_{PZH}	$\overline{OE}$	B	5.6	1	10.1	0.5	8.1	0.5	5.9	0.5	5.2	ns
t_{PZL}			5.6	1	10.1	0.5	8.1	0.5	5.9	0.5	5.2	
t_{PHZ}	$\overline{OE}$	A	4.5	1.5	9.1	1.5	9.1	1.5	9.1	1.5	9.1	ns
t_{PLZ}			4.5	1.5	9.1	1.5	9.1	1.5	9.1	1.5	9.1	
t_{PHZ}	$\overline{OE}$	B	5.5	1.5	8.7	1.5	7.5	1	6.5	1	6.3	ns
t_{PLZ}			5.5	1.5	8.7	1.5	7.5	1	6.5	1	6.3	

7.8 Switching Characteristics: $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$

over recommended operating free-air temperature range, $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$ (see 图 8-1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	3.4	0.5	5.9	0.5	4.8	0.5	3.7	0.5	3.3	ns
t_{PHL}			3.4	0.5	5.9	0.5	4.8	0.5	3.7	0.5	3.3	
t_{PLH}	B	A	3	0.5	5.2	0.5	4.8	0.5	4.5	0.5	4.4	ns
t_{PHL}			3	0.5	5.2	0.5	4.8	0.5	4.5	0.5	4.4	
t_{PZH}	$\overline{OE}$	A	3.4	1	7.8	1	7.8	1	7.8	1	7.8	ns
t_{PZL}			3.4	1	7.8	1	7.8	1	7.8	1	7.8	
t_{PZH}	$\overline{OE}$	B	5.4	1	9.2	0.5	7.4	0.5	5.3	0.5	4.5	ns
t_{PZL}			5.4	1	9.2	0.5	7.4	0.5	5.3	0.5	4.5	
t_{PHZ}	$\overline{OE}$	A	4.2	1.5	7.7	1.5	7.7	1.5	7.7	1.5	7.7	ns
t_{PLZ}			4.2	1.5	7.7	1.5	7.7	1.5	7.7	1.5	7.7	
t_{PHZ}	$\overline{OE}$	B	5.2	1.5	8.4	1.5	7.1	1	5.9	1	5.7	ns
t_{PLZ}			5.2	1.5	8.4	1.5	7.1	1	5.9	1	5.7	

7.9 Switching Characteristics: $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$

over recommended operating free-air temperature range, $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$ (see 图 8-1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	3.2	0.5	5.6	0.5	4.5	0.5	3.3	0.5	2.8	ns
t_{PHL}			3.2	0.5	5.6	0.5	4.5	0.5	3.3	0.5	2.8	
t_{PLH}	B	A	2.6	0.5	4.1	0.5	3.7	0.5	3.3	0.5	3.2	ns
t_{PHL}			2.6	0.5	4.1	0.5	3.7	0.5	3.3	0.5	3.2	
t_{PZH}	$\overline{OE}$	A	2.5	0.5	5.3	0.5	5.3	0.5	5.3	0.5	5.3	ns
t_{PZL}			2.5	0.5	5.3	0.5	5.3	0.5	5.3	0.5	5.3	
t_{PZH}	$\overline{OE}$	B	5.2	0.5	9.4	0.5	7.3	0.5	5.1	0.5	4.5	ns
t_{PZL}			5.2	0.5	9.4	0.5	7.3	0.5	5.1	0.5	4.5	
t_{PHZ}	$\overline{OE}$	A	3	1	6.1	1	6.1	1	6.1	1	6.1	ns
t_{PLZ}			3	1	6.1	1	6.1	1	6.1	1	6.1	
t_{PHZ}	$\overline{OE}$	B	5	1	7.9	1	6.6	1	6.1	1	5.2	ns
t_{PLZ}			5	1	7.9	1	6.6	1	6.1	1	5.2	

7.10 Switching Characteristics: $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$

over recommended operating free-air temperature range, $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ (see 图 8-1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.2\text{ V}$	$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$		$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$		$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	3.2	0.5	5.5	0.5	4.4	0.5	3.2	0.5	2.7	ns
t_{PHL}			3.2	0.5	5.5	0.5	4.4	0.5	3.2	0.5	2.7	
t_{PLH}	B	A	2.8	0.5	3.7	0.5	3.3	0.5	2.8	0.5	2.7	ns
t_{PHL}			2.8	0.5	3.7	0.5	3.3	0.5	2.8	0.5	2.7	
t_{PZH}	$\overline{OE}$	A	2.2	0.5	4.3	0.5	4.2	0.5	4.1	0.5	4	ns
t_{PZL}			2.2	0.5	4.3	0.5	4.2	0.5	4.1	0.5	4	
t_{PZH}	$\overline{OE}$	B	5.1	0.5	9.3	0.5	7.2	0.5	4.9	0.5	4	ns
t_{PZL}			5.1	0.5	9.3	0.5	7.2	0.5	4.9	0.5	4	
t_{PHZ}	$\overline{OE}$	A	3.4	0.5	5	0.5	5	0.5	5	0.5	5	ns
t_{PLZ}			3.4	0.5	5	0.5	5	0.5	5	0.5	5	
t_{PHZ}	$\overline{OE}$	B	4.9	1	7.7	1	6.5	1	5.2	0.5	5	ns
t_{PLZ}			4.9	1	7.7	1	6.5	1	5.2	0.5	5	

7.11 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 to B	Outputs enabled	$C_L = 0,$ $f = 10\text{ MHz},$ $t_r = t_f = 1\text{ ns}$	1	1	1	1	2	pF
		Outputs disabled		1	1	1	1	1	
	B to A	Outputs enabled		13	13	14	15	16	
		Outputs disabled		1	1	1	1	1	
C_{pdB} ⁽¹⁾	A to B	Outputs enabled	$C_L = 0,$ $f = 10\text{ MHz},$ $t_r = t_f = 1\text{ ns}$	13	13	14	15	16	pF
		Outputs disabled		1	1	1	1	1	
	B to A	Outputs enabled		1	1	1	1	2	
		Outputs disabled		1	1	1	1	1	

(1) Power dissipation capacitance per transceiver. Refer to the TI application report, CMOS Power Consumption and C_{pd} Calculation [SCAA035](#).

表 7-1. Typical Total Static Power Consumption ($I_{CCA} + I_{CCB}$)

V_{CCB}	V_{CCA}						UNIT
	0 V	1.2 V	1.5 V	1.8 V	2.5 V	3.3 V	
0 V	0	<1	<1	<1	<1	<1	μA
1.2 V	<1	<2	<2	<2	<2	2	
1.5 V	<1	<2	<2	<2	<2	2	
1.8 V	<1	<2	<2	<2	<2	<2	
2.5 V	<1	2	<2	<2	<2	<2	
3.3 V	<1	2	<2	<2	<2	<2	

7.12 Typical Characteristics

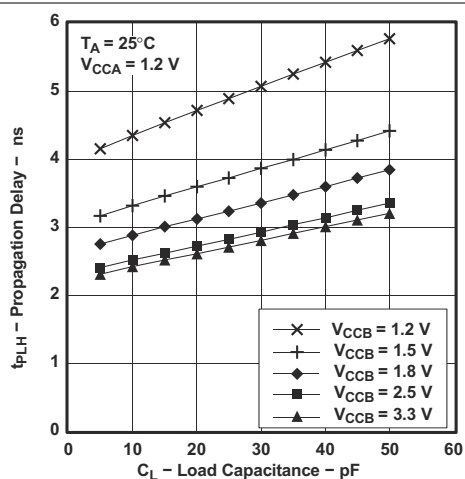


图 7-1. Propagation Delay vs Load Capacitance

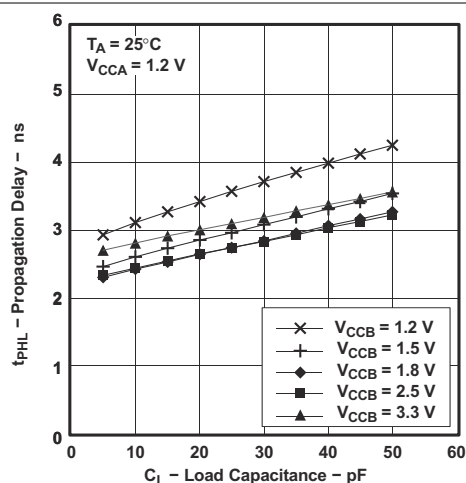
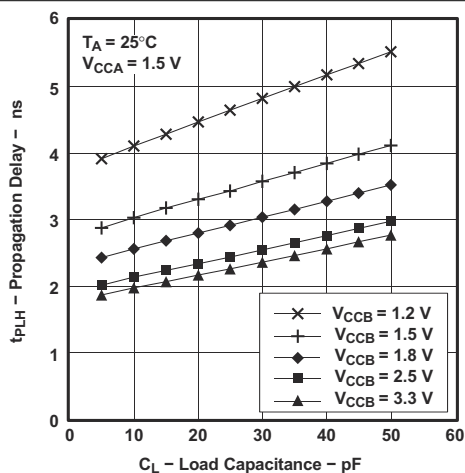
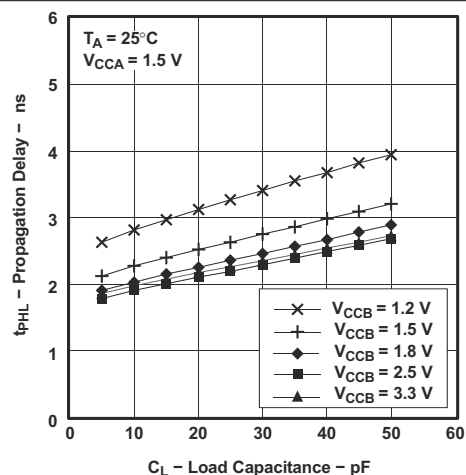


图 7-2. Propagation Delay vs Load Capacitance

图 7-3. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance图 7-4. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

7.12 Typical Characteristics (continued)

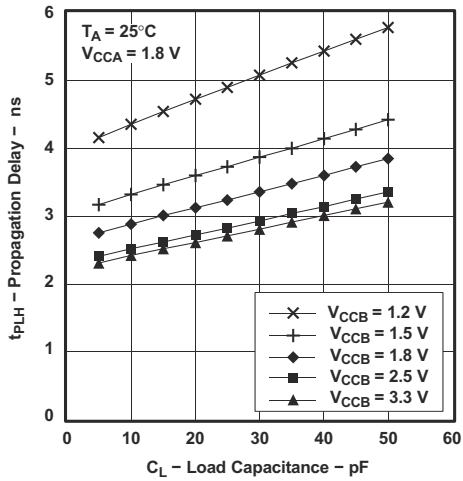


图 7-5. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

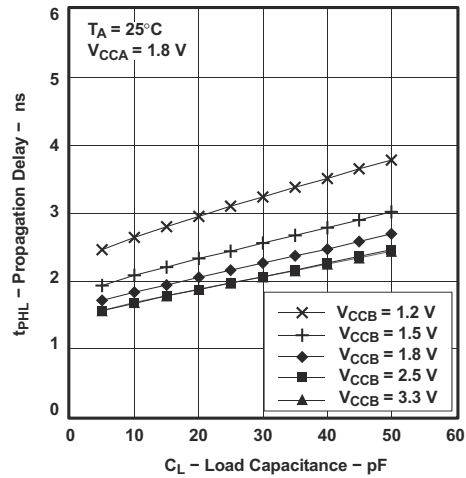


图 7-6. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

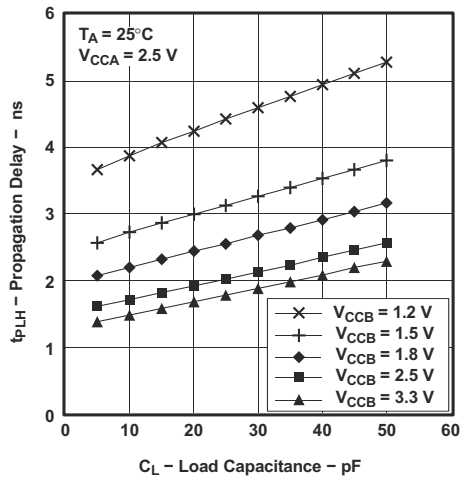


图 7-7. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

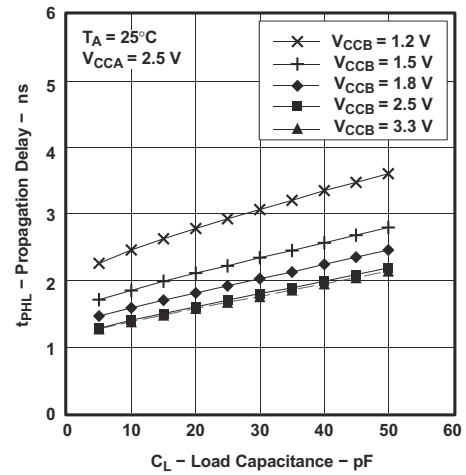


图 7-8. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

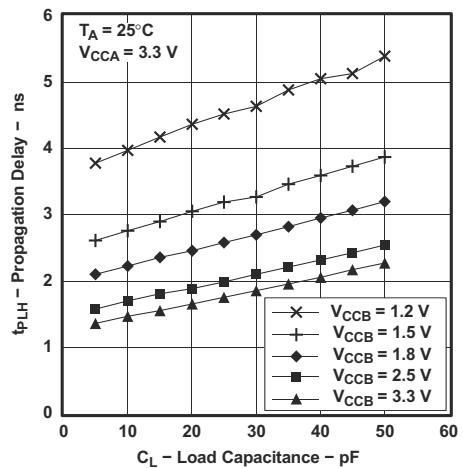


图 7-9. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

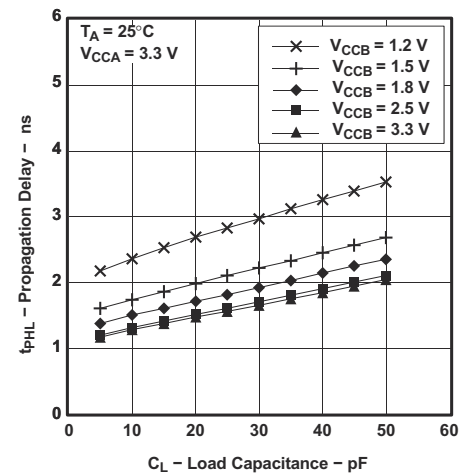
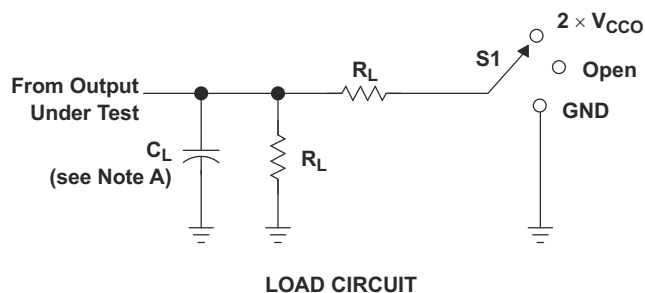


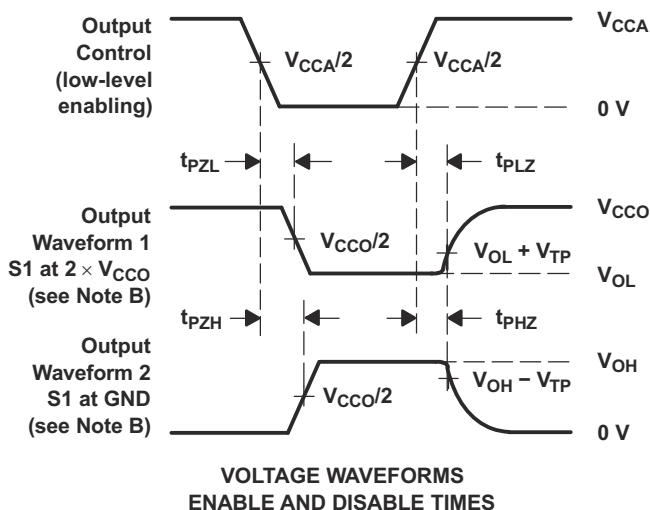
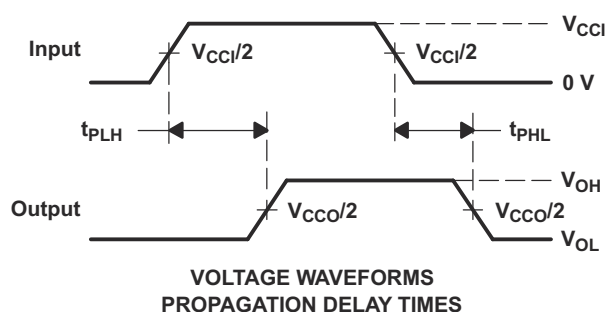
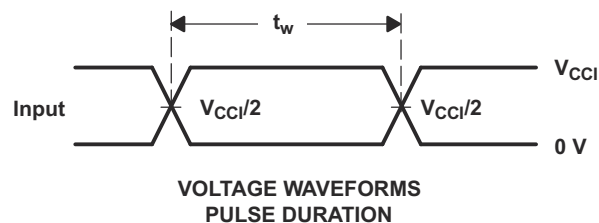
图 7-10. Propagation Delay vs Load Capacitance

8 Parameter Measurement Information



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

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



- 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.

图 8-1. Load Circuit and Voltage Waveforms

9 Detailed Description

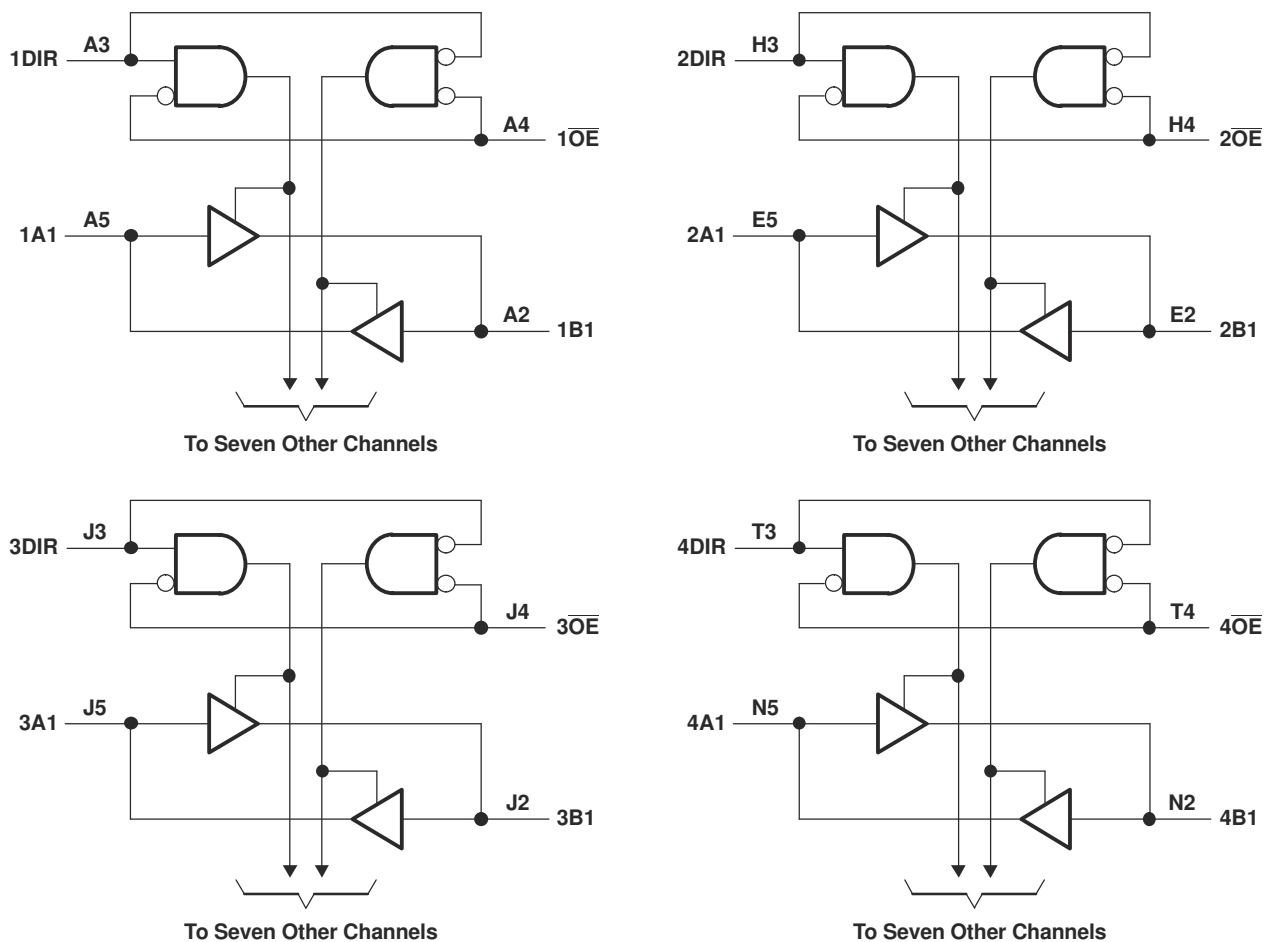
9.1 Overview

The SN74AVC32T245 is a 32-bit, dual-supply noninverting bidirectional voltage level translation. Pins A and control pins (DIR and $\overline{OE}$) are supported by V_{CCA} and pins B are supported by V_{CCB} . The A port can accept I/O voltages ranging from 1.2 V to 3.6 V, while the B port can accept I/O voltages from 1.2 V to 3.6 V. A high on DIR allows data transmission from A to B and a low on DIR allows data transmission from B to A when $\overline{OE}$ is set to low. When $\overline{OE}$ is set to high, both A and B are in the high-impedance state.

This device is fully specified for partial-power-down applications using off output current (I_{off}).

The V_{CC} isolation feature ensures that if either V_{CC} input is at GND, both ports are put in a high-impedance state.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.2-V to 3.6-V Power-Supply Range

Both V_{CCA} and V_{CCB} can be supplied at any voltage from 1.2 V to 3.6 V which makes the device suitable for translating between any of the low voltage nodes (1.2 V, 1.8 V, 2.5 V, and 3.3 V).

9.3.2 Partial-Power-Down Mode Operation

This device is fully specified for partial-power-down applications using off output current (I_{off}). The I_{off} circuitry will prevent backflow current by disabling I/O output circuits when device is in partial power-down mode.

9.3.3 V_{CC} Isolation

The V_{CC} isolation feature ensures that if either V_{CCA} or V_{CCB} are at GND, both ports will be in a high-impedance state (I_{OZ}). This prevents false logic levels from being presented to either bus.

9.4 Device Functional Modes

The SN74AVC32T245 is a voltage level translator that can operate from 1.2 V to 3.6 V (V_{CCA}) and 1.2 V to 3.6 V (V_{CCB}). The signal translation between 1.2 V and 3.6 V requires direction control and output enable control. When $\overline{OE}$ is low and DIR is high, data transmission is from A to B. When $\overline{OE}$ is low and DIR is low, data transmission is from B to A. When $\overline{OE}$ is high, both output ports will be high-impedance.

**表 9-1. Function Table
(Each 8-Bit Section)**

INPUTS		OPERATION
$\overline{OE}$	DIR	
L	L	B data to A bus
L	H	A data to B bus
H	X	Isolation

10 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

The SN74AVC32T245 device can be used in level-shifting applications for interfacing devices and addressing mixed voltage incompatibility. The SN74AVC32T245 device is ideal for data transmission where direction is different for each channel.

10.2 EnableTimes

Calculate the enable times for the SN74AVC32T245 using the following formulas:

$$t_{PZH} \text{ (DIR to A)} = t_{PLZ} \text{ (DIR to B)} + t_{PLH} \text{ (B to A)} \quad (1)$$

$$t_{PZL} \text{ (DIR to A)} = t_{PHZ} \text{ (DIR to B)} + t_{PHL} \text{ (B to A)} \quad (2)$$

$$t_{PZH} \text{ (DIR to B)} = t_{PLZ} \text{ (DIR to A)} + t_{PLH} \text{ (A to B)} \quad (3)$$

$$t_{PZL} \text{ (DIR to B)} = t_{PHZ} \text{ (DIR to A)} + t_{PHL} \text{ (A to B)} \quad (4)$$

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 SN74AVC32T245 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.

10.3 Typical Application

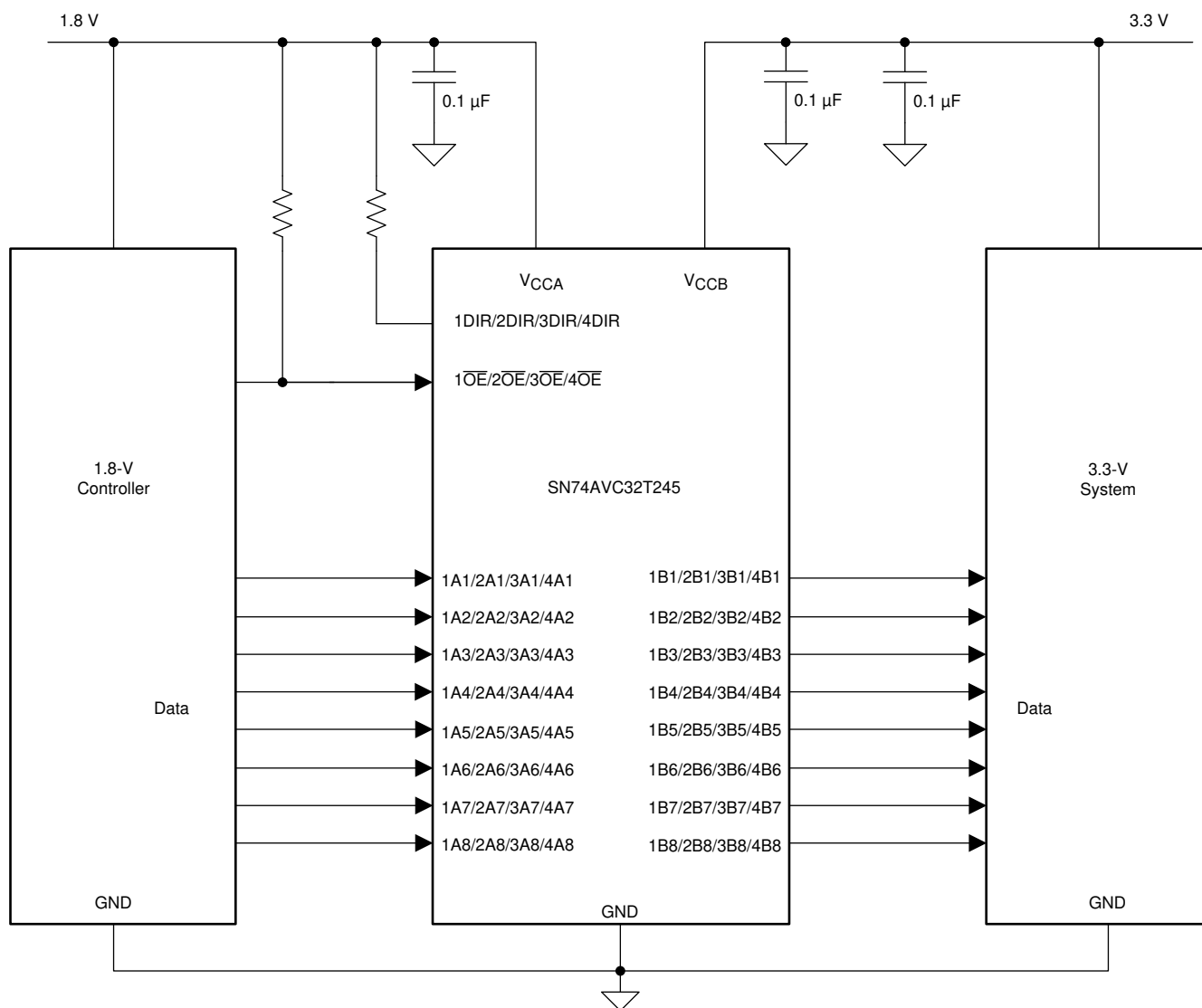


图 10-1. Application Schematic

10.3.1 Design Requirements

This device uses drivers which are enabled depending on the state of the DIR pin. The designer must know the intended flow of data and take care not to violate any of the high or low logic levels. Unused data inputs must not be floating, as this can cause excessive internal leakage on the input CMOS structure. Tie any unused input and output ports directly to ground.

For this design example, use the parameters listed in the *Electrical Characteristics*.

表 10-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input voltage range	1.2 V to 3.6 V
Output voltage range	1.2 V to 3.6 V

10.3.2 Detailed Design Procedure

See 节 10.3.2.1 and 节 10.3.2.2 for information about how to begin the design process.

10.3.2.1 Input Voltage Ranges

Use the supply voltage of the device that is driving the SN74AVC32T245 device to determine the input voltage range. For a valid logic high the value must exceed the V_{IH} of the input port. For a valid logic low the value must be less than the V_{IL} of the input port.

10.3.2.2 Output Voltage Range

Use the supply voltage of the device that the SN74AVC32T245 device is driving to determine the output voltage range.

10.3.3 Application Curve

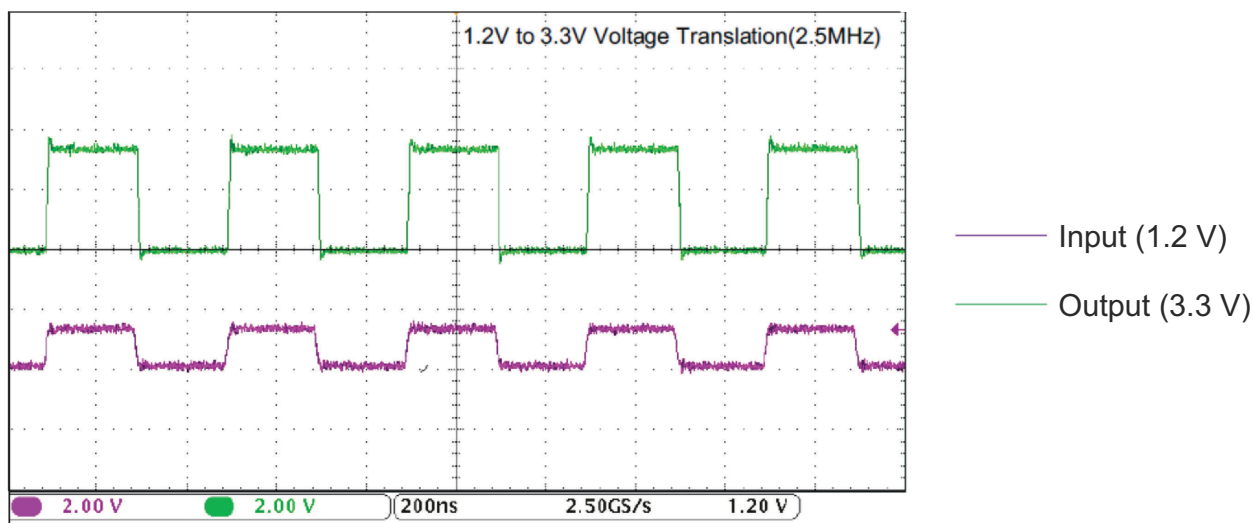


图 10-2. Translation Up (1.2 V to 3.3 V) at 2.5 MHz

11 Power Supply Recommendations

The SN74AVC32T245 device uses two separate configurable power-supply rails, V_{CCA} and V_{CCB} . V_{CCA} accepts any supply voltage from 1.2 V to 3.6 V and V_{CCB} accepts any supply voltage from 1.2 V to 3.6 V. The A port and B port are designed to track V_{CCA} and V_{CCB} , respectively, allowing for low-voltage bidirectional translation between any of the 1.2 V, 1.5 V, 1.8 V, 2.5 V and 3.3 V voltage nodes.

The output-enable $\overline{OE}$ input circuit is designed so that it is supplied by V_{CCA} and when the $\overline{OE}$ input is high, all outputs are placed in the high-impedance state. To ensure the high-impedance state of the outputs during power up or power down, the $\overline{OE}$ input pin must be tied to V_{CCA} through a pullup resistor and must not be enabled until V_{CCA} and V_{CCB} are fully ramped and stable. The minimum value of the pullup resistor to V_{CCA} is determined by the current-sinking capability of the driver.

12 Layout

12.1 Layout Guidelines

To ensure reliability of the device, following common printed-circuit-board layout guidelines is recommended.

- Bypass capacitors must be used on power supplies.
- Short trace lengths must be used to avoid excessive loading.
- Place pads on the signal paths for loading capacitors or pullup resistors to help adjust rise and fall times of signals, depending on the system requirements.

12.2 Layout Example

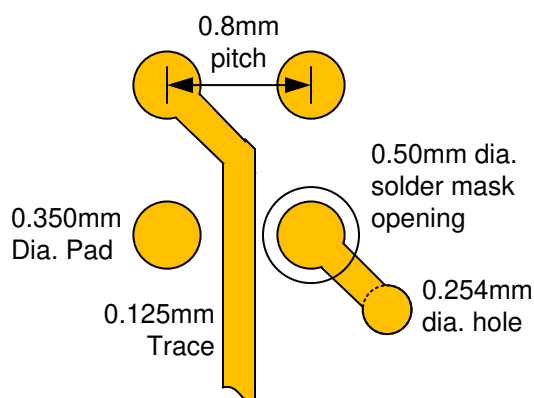


图 12-1. BGA Layout Example

13 Device and Documentation Support

13.1 Documentation Support

13.1.1 Related Documentation

For related documentation, see the following:

13.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

13.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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13.4 Trademarks

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13.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

13.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

14 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AVC32T245NMJR	ACTIVE	NFBGA	NMJ	96	1000	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	29UW	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

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

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

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

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

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

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

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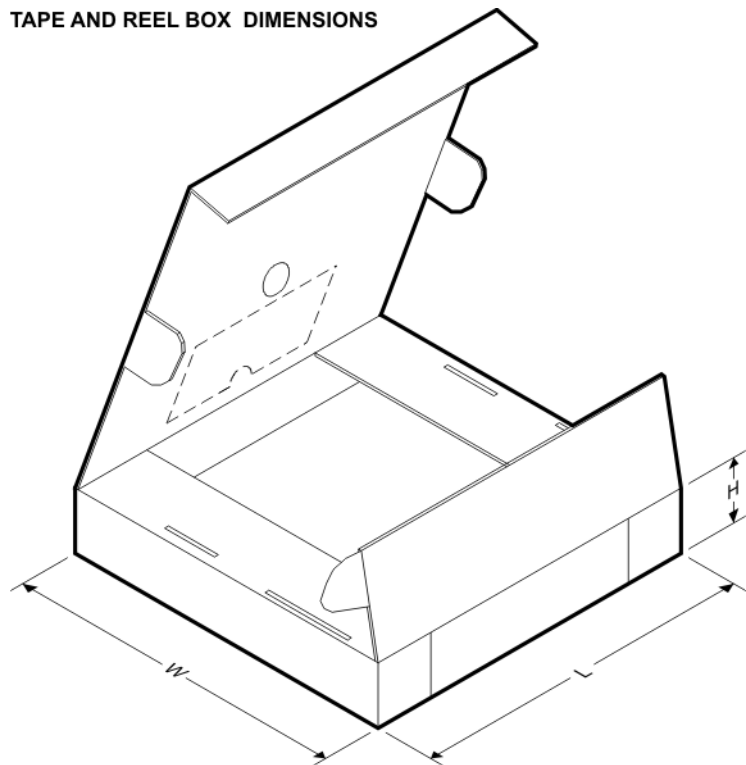
TAPE AND REEL INFORMATION



*All dimensions are nominal

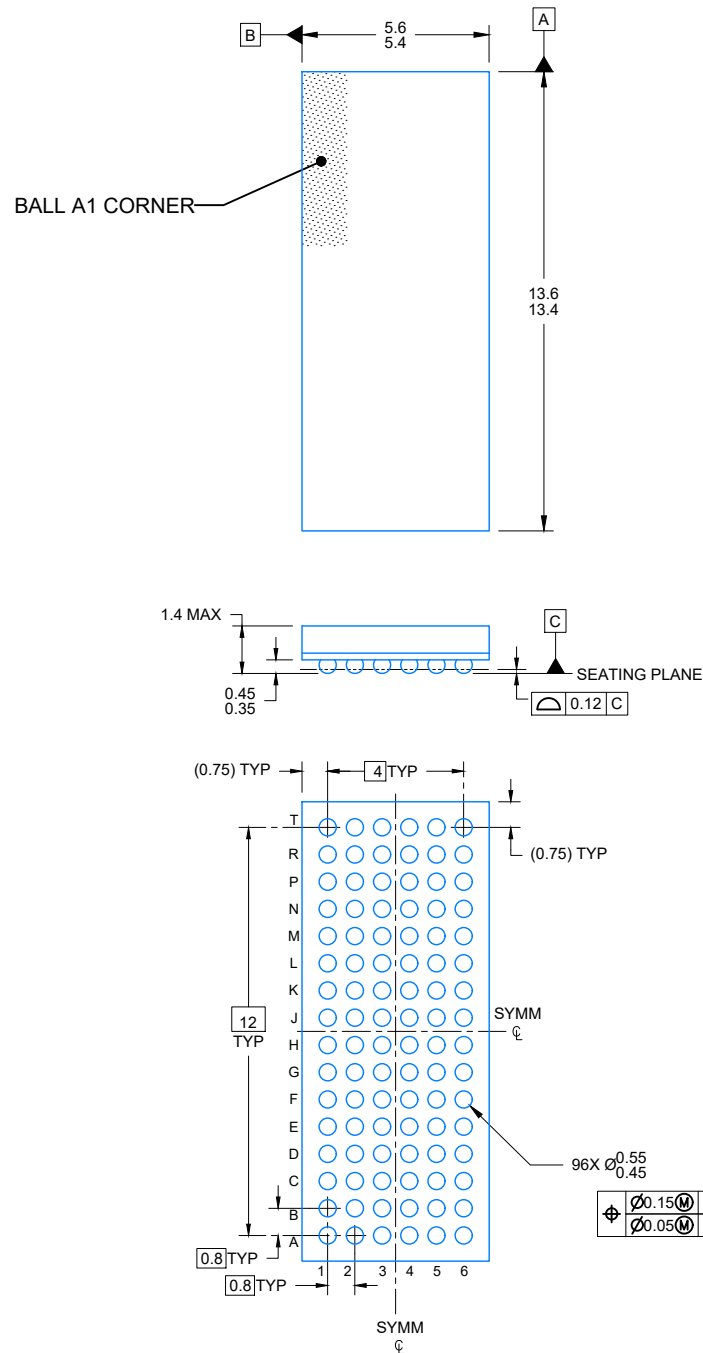
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AVC32T245NMJR	NFBGA	NMJ	96	1000	330.0	24.4	5.85	13.85	1.8	8.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVC32T245NMJR	NFBGA	NMJ	96	1000	336.6	336.6	41.3

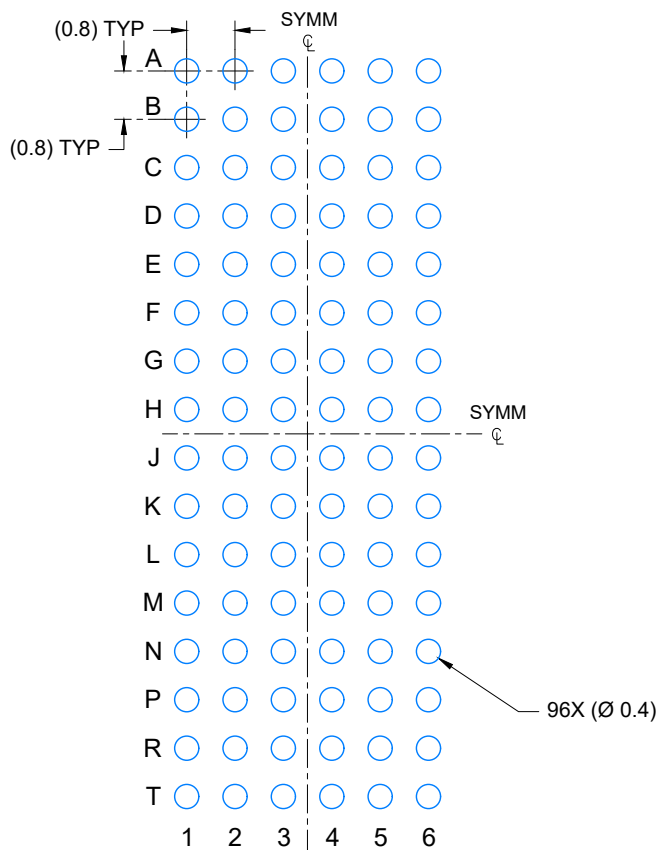


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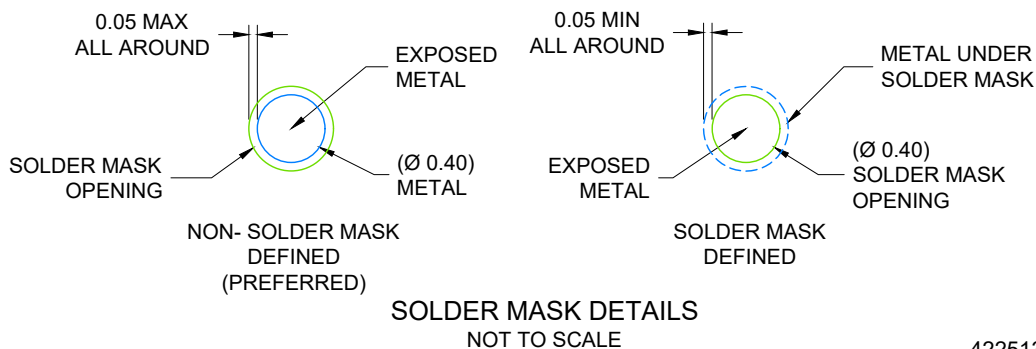
NOTES:

NanoFree is a trademark of Texas Instruments.

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.



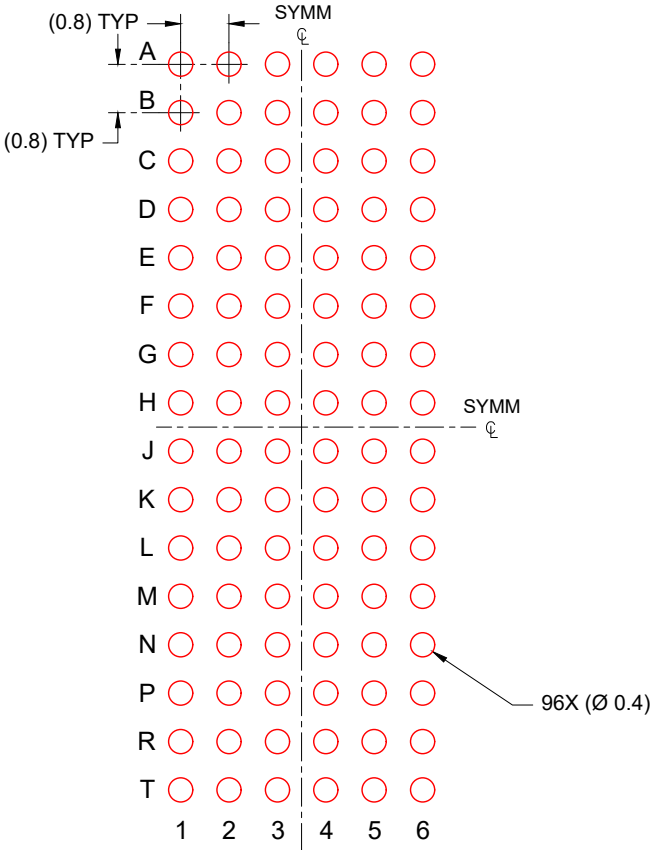
LAND PATTERN EXAMPLE
SCALE: 8X



4225132/A 08/2019

NOTES: (continued)

- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. Refer to Texas Instruments Literature number SNVA009 (www.ti.com/lit/snva009).



SOLDER PASTE EXAMPLE
BASED ON 0.150 mm THICK STENCIL
SCALE: 8X

NOTES: (continued)

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

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