





SN74AVC16T245 SCES551F - FEBRUARY 2004 - REVISED MARCH 2024

SN74AVC16T245 16-Bit Dual-Supply Bus Transceiver with Configurable Level-Shifting / Voltage Translation and Tri-State Outputs

1 Features

- Control Inputs V_{IH}/V_{II} Levels Are Referenced to V_{CCA} Voltage
- V_{CC} Isolation Feature If Either V_{CC} Input Is at GND, Both Ports Are in the High-Impedance State
- Overvoltage-Tolerant Inputs and Outputs Allow Mixed-Voltage-Mode Data Communications
- Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.2V to 3.6V Power-Supply Range
- I_{off} Supports Partial-Power-Down Mode Operation
- I/Os Are 4.6V Tolerant
- Maximum Data Rates
 - 380Mbps (1.8V to 3.3V Level-Shifting)
 - 200Mbps (<1.8V to 3.3V Level-Shifting)
 - 200Mbps (Level-Shifting to 2.5V or 1.8V)
 - 150Mbps (Level-Shifting to 1.5V)
 - 100Mbps (Level-Shifting to 1.2V)
- Latch-Up Performance Exceeds 100mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 8000V Human-Body Model (A114-A)
 - 200V Machine Model (A115-A)
 - 1000V Charged-Device Model (C101)

2 Applications

- Personal Electronics
- Industrial
- **Enterprise**
- Telecom

1DIR 48 10E To Seven Other Channels

3 Description

This 16-bit noninverting bus transceiver two separate configurable power-supply rails. The SN74AVC16T245 device is optimized to operate with V_{CCA}/V_{CCB} set at 1.4V to 3.6V. The device is operational with V_{CCA}/V_{CCB} as low as 1.2V. The A port is designed to track V_{CCA} . V_{CCA} accepts any supply voltage from 1.2V to 3.6V. The B port is designed to track V_{CCB}. V_{CCB} accepts any supply voltage from 1.2V to 3.6V. This allows for universal low-voltage bidirectional translation between any of the 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V voltage nodes.

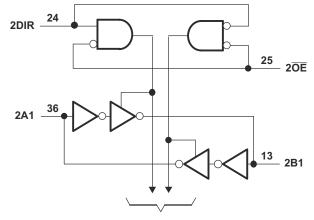
The SN74AVC16T245 device is designed for asynchronous communication between data buses. The device transmits data from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable (\overline{OE}) input can be used to disable the outputs so the buses effectively are isolated.

The SN74AVC16T245 control pins (1DIR, 2DIR, 1 \overline{OE} , and 2 \overline{OE}) are supplied by V_{CCA} .

Device Information

_							
PART NUMBER	PACKAGE ⁽¹⁾	BODY SIZE (NOM)					
	TSSOP (48)	12.50 mm × 6.10mm					
SN74AVC16T245	TVSOP (48)	9.70 mm × 4.40mm					
	BGA MICROSTAR JUNIOR (56)	7.00 mm × 4.50mm					

For all available packages, see the orderable addendum at the end of the data sheet.



To Seven Other Channels

Logic Diagram (Positive Logic)



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4 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, both ports are in the high-impedance state.

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



5 Pin Configuration and Functions

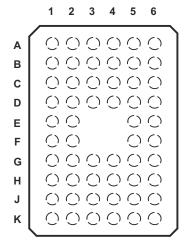


Figure 5-1. GQL or ZQL Package 56-Pin BGA MICROSTAR JUNIOR Top View

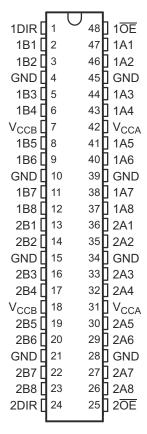


Figure 5-2. DGG or DGV Package 48-Pin TSSOP or TVSOP Top View

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Pin Functions

			•	iii uncuona
	PIN			
NAME	TSSOP, TVSOP	BGA MICROSTAR	I/O	DESCRIPTION
1DIR, 2DIR	1, 24	A1, K1	I	Direction-control signal
1B1 to 1B8	2, 3, 5, 6, 8, 9, 11, 12	B2, B1, C2, C1, D2, D1, E2, E1	I/O	Input/Output. Referenced to V _{CCB}
2B1 to 2B8	13, 14, 16, 17, 19, 20, 22, 23	F1, F2, G1, G2, H1, H2, J1, J2	I/O	Input/Output. Referenced to V _{CCB}
GND	4, 10, 15, 21, 45, 39, 34, 28	B3, D3, G3, J3, J4, G4, D4, B4	_	Ground
V _{CCB}	7, 18	C3, H3	_	B-port supply voltage. 1.2 V ≤ V _{CCB} ≤ 3.6 V
1 OE , 2 OE	48, 25	A6, K6	_	Tri-State output-mode enables. Pull $\overline{\text{OE}}$ high to place all outputs in Tri-State mode. Referenced to V_{CCA}
1A1 to 1A8	47, 46, 44, 43, 41, 40, 38, 37	B5, B6, C5, C6, D5, D6, E5, E6	I/O	Input/Output. Referenced to V _{CCA}
2A1 to 2A8	36, 35, 33, 32, 30, 29, 27, 26	F6, F5, G6, G5, H6, H5, J6, J5	I/O	Input/Output. Referenced to V _{CCA}
V _{CCA}	42, 31	C4, H4	_	A-port supply voltage. 1.2 V ≤ V _{CCB} ≤ 3.6 V
N.C.	_	A2, A3, A4, A5, K2, K3, K4, K5	_	No internal connection



6 Specifications

6.1 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
		I/O ports (A port)	-0.5	4.6	
V_{I}	Input voltage ⁽²⁾	I/O ports (B port)	-0.5	4.6	V
		Control inputs	-0.5	4.6	
V	Voltage range applied to any output in the high-impedance or power-	A port	-0.5	4.6	V
Vo	off state ⁽²⁾	B port	-0.5	4.6	\ \ \
V	Valtage range applied to any output in the high ar law state(2) (3)	A port	-0.5	V _{CCA} + 0.5	V
Vo	Voltage range applied to any output in the high or low state ^{(2) (3)}	B port	-0.5	V _{CCB} + 0.5	V
I _{IK}	Input clamp current	V _I < 0		-50	mA
I _{OK}	Output clamp current	V _O < 0		-50	mA
Io	Continuous output current			±50	mA
	Continuous current through each V _{CCA} , V _{CCB} , and GND			±100	mA
		DGG package		70	
$R_{\theta JA}$	Package thermal impedance ⁽⁴⁾	DGV package		58	°C/W
		GQL/ZQL package		42	
TJ	Junction temperature		-40	150	°C
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, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- (2) The input voltage (V_I) and output negative-voltage (V_O) 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.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

6.2 ESD Ratings

			VALUE	UNIT
		Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±8000	
V _(ESD)	Electrostatic discharge	Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000	V
		Machine model (A115-A)	±200	

⁽¹⁾ JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.

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⁽²⁾ JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.



6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)(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
			1.2 V to 1.95 V		V _{CCI} × 0.65		
V_{IH}	High-level input voltage	Data inputs ⁽⁴⁾	1.95 V to 2.7 V		1.6		V
	mpat voltage		2.7 V to 3.6 V		2		
			1.2 V to 1.95 V			V _{CCI} × 0.35	
V_{IL}	Low-level input voltage	Data inputs ⁽⁴⁾	1.95 V to 2.7 V			0.7	V
	input voltage		2.7 V to 3.6 V			0.8	
		DIR	1.2 V to 1.95 V		V _{CCA} × 0.65		
V_{IH}	High-level input voltage	(referenced to	1.95 V to 2.7 V		1.6		V
	input voitage	V _{CCA}) ⁽⁵⁾	2.7 V to 3.6 V		2		
		DIR	1.2 V to 1.95 V			V _{CCA} × 0.35	
V_{IL}	Low-level (referenced to		1.95 V to 2.7 V			0.7	V
	input voltage	V _{CCA}) ⁽⁵⁾	2.7 V to 3.6 V			0.8	
VI	Input voltage				0	3.6	V
V	Outrout walterna	Active state			0	V _{CCO}	V
Vo	Output voltage	Tri-State			0	3.6	V
				1.2 V		-3	
				1.4 V to 1.6 V		-6	
I _{OH}	High-level output	current		1.65 V to 1.95 V		-8	mA
				2.3 V to 2.7 V		– 9	
				3 V to 3.6 V		-12	
				1.2 V		3	
				1.4 V to 1.6 V		6	
I_{OL}	Low-level output	current		1.65 V to 1.95 V		8	mA
				2.3 V to 2.7 V		9	
				3 V to 3.6 V		12	
Δt/Δν	Input transition ris	se 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.

6.4 Thermal Information

			SN74AVC16T245								
THERMAL METRIC(1)		DGV (TVSOP)	DGG (TSSOP)	ZQL (BGA MICROSTAR JUNIOR)	UNIT						
		48 PINS	48 PINS	56 PINS							
$R_{\theta JA}$	Junction-to-ambient thermal resistance	82.5	69.9	64.6	°C/W						
R _{θJC(top)}	Junction-to-case (top) thermal resistance	34.2	23.9	16.6	°C/W						
$R_{\theta JB}$	Junction-to-board thermal resistance	45.1	36.6	30.8	°C/W						
ΨЈТ	Junction-to-top characterization parameter	2.7	1.7	0.9	°C/W						

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

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



6.4 Thermal Information (continued)

		SN74AVC16T245									
THERMAL METRIC ⁽¹⁾		DGV (TVSOP)	ZQL (BGA MICROSTAR JUNIOR)	UNIT							
		48 PINS	48 PINS	56 PINS							
Ψ_{JB}	Junction-to-board characterization parameter	44.6	36.2	64.6	°C/W						

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

6.5 Electrical Characteristics

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

DAD	AMETED	TEST COND	NTIONS	v	V		T _A = 25°C		T _A = -40°	C to 85°C		UNIT
PAR	AMETER	TEST COND	IIIONS	V _{CCA}	V _{CCB}	MIN	TYP	MAX	MIN	TYP	MAX	UNII
		I _{OH} = -100 μA		1.2 V to 3.6 V	1.2 V to 3.6 V				V _{CCO} - 0.2			
		$I_{OH} = -3 \text{ mA}$		1.2 V	1.2 V		0.95					
,,		I _{OH} = -6 mA	V _I = V _{IH}	1.4 V	1.4 V				1.05			V
V _{OH}		I _{OH} = -8 mA	VI = VIH	1.65 V	1.65 V				1.2			V
		I _{OH} = -9 mA		2.3 V	2.3 V				1.75			
	I _{OH} = -12 mA			3 V	3 V				2.3			
		I _{OL} = 100 μA		1.2 V to 3.6 V	1.2 V to 3.6 V						0.2	
		I _{OL} = 3 mA		1.2 V	1.2 V		0.15					
,,		I _{OL} = 6 mA	V _I = V _{IL}	1.4 V	1.4 V						0.35	V
V _{OL}		I _{OL} = 8 mA		1.65 V	1.65 V						0.45	V
		I _{OL} = 9 mA		2.3 V	2.3 V						0.55	
		I _{OL} = 12 mA		3 V	3 V						0.7	
I ₁	Control inputs	V _I = V _{CCA} or GNI	D	1.2 V to 3.6 V	1.2 V to 3.6 V		±0.025	±0.25			±1	μΑ
	A or B port	V -=V - 0 t- 0	C. V.	0 V	0 to 3.6 V		±0.1	±2.5			±5	
I _{off}	A or B port	V_I or $V_O = 0$ to 3.	.b V	0 to 3.6 V	0 V		±0.5	±2.5			±5	μA
I _{OZ} (3)	A or B port	$V_O = V_{CCO}$ or GND $V_I = V_{CCI}$ or GND $\overline{OE} = V_{IH}$	ND,),	3.6 V	3.6 V		±0.5	±2.5			±5	μΑ
				1.2 V to 3.6 V	1.2 V to 3.6 V						25	
I _{CCA}		$V_I = V_{CCI}$ or GND $I_O = 0$),	0 V	3.6 V						-5	μΑ
		.0 0		3.6 V	0 V						25	
				1.2 V to 3.6 V	1.2 V to 3.6 V						25	
I _{CCB}		$V_I = V_{CCI}$ or GND $I_O = 0$),	0 V	3.6 V						25	μΑ
		.0 0		3.6 V	0 V						-5	
I _{CCA} +	Іссв	$V_I = V_{CCI}$ or GND $I_O = 0$),	1.2 V to 3.6 V	1.2 V to 3.6 V						45	μΑ
Ci	Control inputs	V _I = 3.3 V or GN	D	3.3 V	3.3 V		3.5					pF
C _{io}	A or B port	V _O = 3.3 V or GN	1D	3.3 V	3.3 V		7					pF

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

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⁽²⁾ V_{CCI} is the V_{CC} associated with the input port.

⁽³⁾ For I/O ports, the parameter I_{OZ} includes the input leakage current.

6.6 Switching Characteristics: V_{CCA} = 1.2 V

over recommended operating free-air temperature range, V_{CCA} = 1.2 V (see Figure 7-1)

PARAMETER	FROM	то	V _{CCB} =	1.2 V	Vc	_{CB} = 1.5 \		Vcc	_{CB} = 1.8 V		Vcc	_B = 2.5	v	Vcc	_{:B} = 3.3	s v	UNIT
PARAMETER	(INPUT)	(OUTPUT)	MIN TY	P MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNII
t _{PLH}	А	В	4	.1		3.3			3			2.8			3.2		ns
t _{PHL}	^	Ь	4	.1		3.3			3			2.8			3.2		115
t _{PLH}	В	А	4	.4		4			3.8			3.6			3.5		ns
t _{PHL}	В		4	.4		4			3.8			3.6			3.5		115
t _{PZH}	ŌĒ	А	6	.4		6.4			6.4			6.4			6.4		ns
t _{PZL}	OL	7	6	.4		6.4			6.4			6.4			6.4		113
t _{PZH}	ŌĒ	В		6		4.6			4			3.4			3.2		ns
t _{PZL}	OL	Ь		6		4.6			4			3.4			3.2		115
t _{PHZ}	ŌĒ	А	6	.6		6.6			6.6			6.6			6.8		ns
t _{PLZ}	OE.	χ.	6	.6		6.6			6.6			6.6			6.8		110
t _{PHZ}	ŌĒ	В		6		4.9			4.9			4.2			5.3		ns
t _{PLZ}	OL			6		4.9			4.9			4.2			5.3		113

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

over recommended operating free-air temperature range, V_{CCA} = 1.5 V ± 0.1 V (see Figure 7-1)

PARAMETER	FROM	то	V _{CCB} = 1	.2 V	V _{CCB} =	1.5 V ± 0.1	v	V _{CCB} = 1.8	8 V ± 0.15	V	V _{CCB} = 2	2.5 V ± 0).2 V	V _{CCB} =	3.3 V ± ().3 V	UNIT	
PARAWETER	(INPUT)	(OUTPUT)	MIN TY	Р МАХ	MIN	TYP M	AX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNII	
t _{PLH}	Α	В	3	6	0.5		6.2	0.5		5.2	0.5		4.1	0.5		3.7	ns	
t _{PHL}	A	В	3	6	0.5		6.2	0.5		5.2	0.5		4.1	0.5		3.7	115	
t _{PLH}	В	А	3	3	0.5		6.2	0.5		5.9	0.5		5.6	0.5		5.5	ns	
t _{PHL}	ь	^	3	3	0.5		6.2	0.5		5.9	0.5		5.6	0.5		5.5	115	
t _{PZH}	ŌĒ	^	4	3	1	1	0.1	1		10.1	1		10.1	1		10.1	ns	
t _{PZL}	OE	A	4	3	1	1	0.1	1		10.1	1		10.1	1		10.1	115	
t _{PZH}	ŌĒ	В	5	6	1	1	0.1	0.5		8.1	0.5		5.9	0.5		5.2	ns	
t _{PZL}	OL	6	5	6	1	1	0.1	0.5		8.1	0.5		5.9	0.5		5.2	113	
t _{PHZ}	OF	^	4	5	1.5		9.1	1.5		9.1	1.5		9.1	1.5		9.1		
t _{PLZ}	ŌE	ŌE A	4	5	1.5		9.1	1.5		9.1	1.5		9.1	1.5		9.1	ns	
t _{PHZ}	OE.	В	5	5	1.5		8.7	1.5		7.5	1		6.5	1		6.3	ns	
t _{PLZ}	ŌĒ	ŌĒ	6	5	5	1.5		8.7	1.5		7.5	1		6.5	1		6.3	115

6.8 Switching Characteristics: V_{CCA} = 1.8 V ± 0.15 V

over recommended operating free-air temperature range, V_{CCA} = 1.8 V ± 0.15 V (see Figure 7-1)

PARAMETER	FROM	то	Vcc	_B = 1.2 V		V _{CCB} =	1.5 V ± 0.1	١٧	V _{CCB} =	1.8 V ± 0.	.15 V	V _{CCB} =	2.5 V ± 0).2 V	V _{CCB} = :	3.3 V ±	0.3 V	UNIT							
PARAMETER	(INPUT)	(OUTPUT)	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNII							
t _{PLH}	Α	В		3.4		0.5		5.9	0.5		4.8	0.5		3.7	0.5		3.3	ns							
t _{PHL}	A	В		3.4		0.5		5.9	0.5		4.8	0.5		3.7	0.5		3.3	ns							
t _{PLH}	В	А		3		0.5		5.2	0.5		4.8	0.5		4.5	0.5		4.4	ns							
t _{PHL}	ь	A		3		0.5		5.2	0.5		4.8	0.5		4.5	0.5		4.4	115							
t _{PZH}	ŌĒ	А		3.4		1		7.8	1		7.8	1		7.8	1		7.8	ns							
t _{PZL}	OE	A		3.4		1		7.8	1		7.8	1		7.8	1		7.8	115							
t _{PZH}	ŌĒ	В		5.4		1		9.2	0.5		7.4	0.5		5.3	0.5		4.5	ns							
t _{PZL}	OE	В		5.4		1		9.2	0.5		7.4	0.5		5.3	0.5		4.5	115							
t _{PHZ}	ŌĒ	А		4.2		1.5		7.7	1.5		7.7	1.5		7.7	1.5		7.7	ns							
t _{PLZ}	OE	A		4.2		1.5		7.7	1.5		7.7	1.5		7.7	1.5		7.7	115							
t _{PHZ}	OE.	В		5.2		1.5		8.4	1.5		7.1	1		5.9	1		5.7	no							
t _{PLZ}	ŌĒ	ŌĒ	ŌĒ	ŌĒ	ŌĒ	ŌĒ	ŌĒ	ŌĒ	0		5.2		1.5		8.4	1.5		7.1	1		5.9	1		5.7	ns

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

over recommended operating free-air temperature range, V_{CCA} = 2.5 V \pm 0.2 V (see Figure 7-1)

						00,1														
PARAMETER	FROM	то	V _{CCB} = 1.2	. V	V _{CCB} =	1.5 V ± 0.	1 V	V _{CCB} = 1	1.8 V ± 0.1	5 V	V _{CCB} =	2.5 V ± 0).2 V	V _{CCB} = 3	3.3 V ±	0.3 V	UNIT			
PARAMETER	(INPUT)	(OUTPUT)	MIN TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNII			
t _{PLH}	Α	В	3.2		0.5		5.6	0.5		4.5	0.5		3.3	0.5		2.8	ns			
t _{PHL}		В	3.2		0.5		5.6	0.5		4.5	0.5		3.3	0.5		2.8	115			
t _{PLH}	В	А	2.6		0.5		4.1	0.5		3.7	0.5		3.3	0.5		3.2	ns			
t _{PHL}	ь	^	2.6		0.5		4.1	0.5		3.7	0.5		3.3	0.5		3.2	115			
t _{PZH}	ŌĒ	Α	2.5		0.5		5.3	0.5		5.3	0.5		5.3	0.5		5.3	ns			
t _{PZL}	OL	^	2.5		0.5		5.3	0.5		5.3	0.5		5.3	0.5		5.3	115			
t _{PZH}	ŌĒ	В	5.2		0.5		9.4	0.5		7.3	0.5		5.1	0.5		4.5	ns			
t _{PZL}	OE	В	В	В	В	5.2		0.5		9.4	0.5		7.3	0.5		5.1	0.5		4.5	115
t _{PHZ}	OE.	^	3		1		6.1	1		6.1	1		6.1	1		6.1	ns			
t _{PLZ}	OE	Α -	ŌĒ A	3		1		6.1	1		6.1	1		6.1	1		6.1	115		
t _{PHZ}	ŌĒ	B	5		1		7.9	1		6.6	1		6.1	1		5.2	ns			
t _{PLZ}		ŌE B	5		1		7.9	1		6.6	1		6.1	1		5.2	113			

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

over recommended operating free-air temperature range, V_{CCA} = 3.3 V ± 0.3 V (see Figure 7-1)

PARAMETER	FROM	то	V _{cci}	_B = 1.2 \	/	V _{CCB} =	1.5 V ± 0.1	٧	V _{CCB} = 1	.8 V ± 0.1	5 V	V _{CCB} = 2	2.5 V ± 0	.2 V	V _{CCB} = 3	3.3 V ±	0.3 V	UNIT				
PARAMETER	(INPUT)	(OUTPUT)	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP I	MAX	MIN	TYP	MAX	UNII				
t _{PLH}	Α	В		3.2		0.5		5.5	0.5		4.4	0.5		3.2	0.5		2.7	ns				
t _{PHL}	_ A			3.2		0.5		5.5	0.5		4.4	0.5		3.2	0.5		2.7	115				
t _{PLH}	В	А		2.8		0.5		3.7	0.5		3.3	0.5		2.8	0.5		2.7	ns				
t _{PHL}	ь	A		2.8		0.5		3.7	0.5		3.3	0.5		2.8	0.5		2.7	115				
t _{PZH}	ŌĒ	А		2.2		0.5		4.3	0.5		4.2	0.5		4.1	0.5		4	200				
t _{PZL}	OE			2.2		0.5		4.3	0.5		4.2	0.5		4.1	0.5		4	ns				
t _{PZH}	ŌĒ	ь		5.1		0.5		9.3	0.5		7.2	0.5		4.9	0.5		4	ns				
t _{PZL}	OE .	В	В	В	В	В		5.1		0.5		9.3	0.5		7.2	0.5		4.9	0.5		4	115
t _{PHZ}	ŌĒ	_		3.4		0.5		5	0.5		5	0.5		5	0.5		5	ns				
t _{PLZ}	OE	UE	OE	A	A	A		3.4		0.5		5	0.5		5	0.5		5	0.5		5	115
t _{PHZ}	OE.	В			4.9		1		7.7	1		6.5	1		5.2	0.5		5	200			
t _{PLZ}	ŌĒ			4.9		1		7.7	1		6.5	1		5.2	0.5		5	ns				

6.11 Operating Characteristics

 $T_{\Delta} = 25^{\circ}C$

I A Z	PARAMETE	R	TEST CONDITIONS	V _{CCA} =	V _{CCB}	3 = 1.2	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} = 3.3 V			UNIT
			CONDITIONS	MIN TYP MAX MIN TYP MAX		MIN	MIN TYP MAX		MIN	TYP	MAX	MIN	TYP	MAX					
	A to B	Outputs enabled			1			1			1			1			2		
C _{pdA} (1)	ALOB	Outputs disabled	$C_L = 0,$ f = 10 MHz,	1		1 1			1		1		pF						
C _{pdA} (*)	Outputs enabled	uts $t_r = t_f = 1 \text{ ns}$		13			13		14				15		16			pr	
	B to A	Outputs disabled		1			1				1		1			1			
	A to B	Outputs enabled			13			13			14			15			16		
C _{pdB} ⁽¹⁾	AIOB	Outputs disabled	C _L = 0, f = 10 MHz,		1			1			1	1 1		1		T _			
OpdB (*)	B to A	Outputs enabled	$t_r = t_f = 1 \text{ ns}$		1			1			1			1			2		pF
		Outputs disabled			1			1			1			1			1		

 Power dissipation capacitance per transceiver. Refer to the TI application report, CMOS Power Consumption and Cpd Calculation, SCAA035

Product Folder Links: SN74AVC16T245

6.12 Typical Characteristics

 $T_A = 25^{\circ}C$

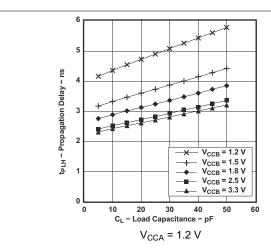


Figure 6-1. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

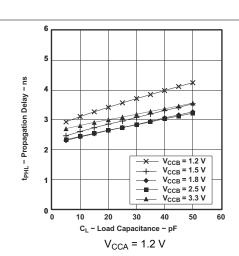


Figure 6-2. Typical Propagation Delay t_{PHL} (A to B) vs Load Capacitance

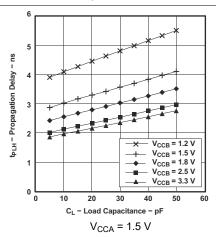


Figure 6-3. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

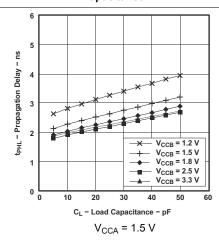


Figure 6-4. Typical Propagation Delay $t_{\rm PHL}$ (A to B) vs Load Capacitance

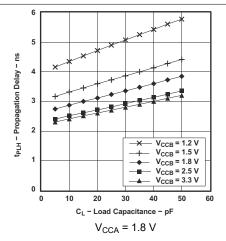


Figure 6-5. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

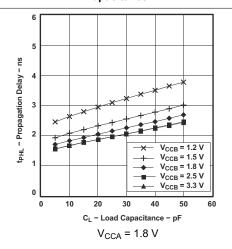


Figure 6-6. Typical Propagation Delay t_{PHL} (A to B) vs Load Capacitance



6.12 Typical Characteristics (continued)

 $T_A = 25^{\circ}C$

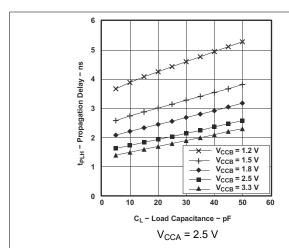


Figure 6-7. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

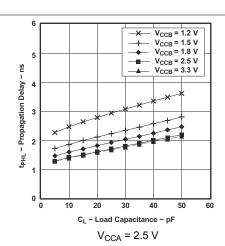


Figure 6-8. Typical Propagation Delay t_{PHL} (A to B) vs Load Capacitance

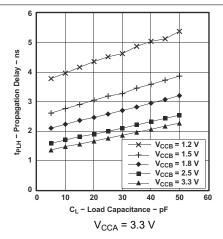


Figure 6-9. Typical Propagation Delay t_{PLH} (A to B) vs Load Capacitance

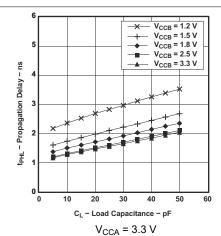


Figure 6-10. Typical Propagation Delay t_{PHL} (A to B) vs Load Capacitance

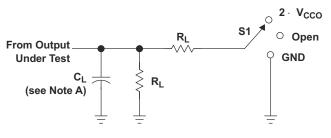
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 V_{CCA}



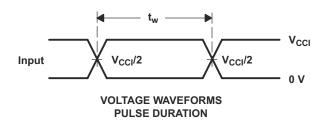
7 Parameter Measurement Information

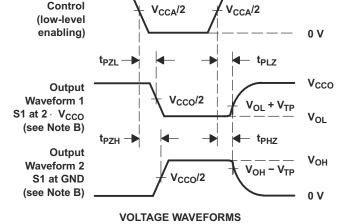


TEST	S 1
t _{pd}	Open
t _{PLZ} /t _{PZL}	2 · V _{CCO}
t _{PHZ} /t _{PZH}	GND

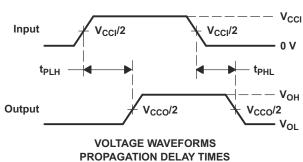
LOAD CIRCUIT

V _{cco}	CL	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 ± 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





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.

Output

- 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_{PLH} and t_{PHL} are the same as t_{pd} .
- F. V_{CCI} is the V_{CC} associated with the input port.
- G. V_{CCO} is the V_{CC} associated with the output port.

Figure 7-1. Load Circuit and Voltage Waveforms



8 Detailed Description

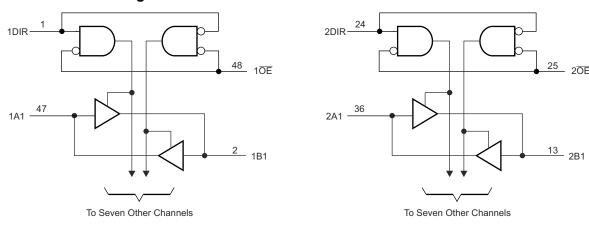
8.1 Overview

The SN74AVC16T245 is a 16-bit, dual-supply noninverting bidirectional voltage level translation. Pins A and control pins (DIR and $\overline{\text{OE}}$) 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 $\overline{\text{OE}}$ is set to low. When $\overline{\text{OE}}$ 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.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 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 making 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).

8.3.2 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.

8.3.3 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} shown in Section 6.5). This prevents false logic levels from being presented to either bus.

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8.4 Device Functional Modes

The SN74AVC16T245 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.

Table 8-1. Functions Table

CONTROL	INPUTS ⁽¹⁾	OUTPUT C	IRCUITS	OPERATION
ŌĒ	DIR	A PORT	B PORT	OPERATION
L	L	Enabled	Hi-Z	B data to A bus
L	Н	Hi-Z	Enabled	A data to B bus
Н	Х	Hi-Z	Hi-Z	Isolation

⁽¹⁾ Input circuits of the data I/Os always are active.

9 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, as well as validating and testing their design implementation to confirm system functionality.

9.1 Application Information

The SN74AVC16T245 device can be used in level-shifting applications for interfacing devices and addressing mixed voltage incompatibility. The SN74AVC16T245 device is ideal for data transmission where direction is different for each channel.

9.1.1 Enable Times

Calculate the enable times for the SN74AVC16T45 using the following formulas:

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

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

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

$$t_{PZL} (DIR to B) = t_{PHZ} (DIR to A) + t_{PHL} (A to B)$$
(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 SN74AVC16T245 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.

Product Folder Links: SN74AVC16T245

9.2 Typical Application

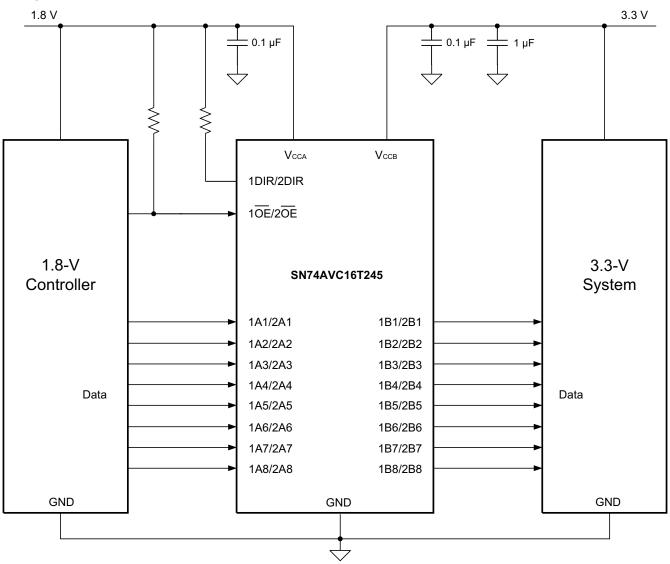


Figure 9-1. Typical Application Schematic

9.2.1 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 Table 9-1.

Table 9-1. Design Parameters

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

9.2.2 Detailed Design Procedure

To begin the design process, determine the following:

9.2.2.1 Input Voltage Ranges

Use the supply voltage of the device that is driving the SN74AVC16T245 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.

9.2.2.2 Output Voltage Range

Use the supply voltage of the device that the SN74AVC16T245 device is driving to determine the output voltage range.

9.2.3 Application Curve

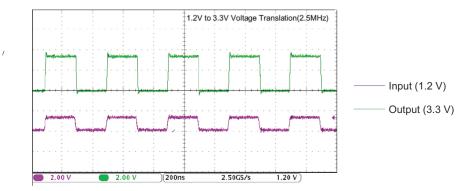


Figure 9-2. Translation Up (1.2 V to 3.3 V) at 2.5 MHz

9.3 Power Supply Recommendations

The SN74AVC16T245 device uses two separate configurable power-supply rails, V_{CCA} and V_{CCB} . VCCA 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.

9.4 Layout

9.4.1 Layout Guidelines

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

- Bypass capacitors should be used on power supplies.
- Short trace lengths should be used to avoid excessive loading.
- Placing 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.

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9.4.2 Layout Example



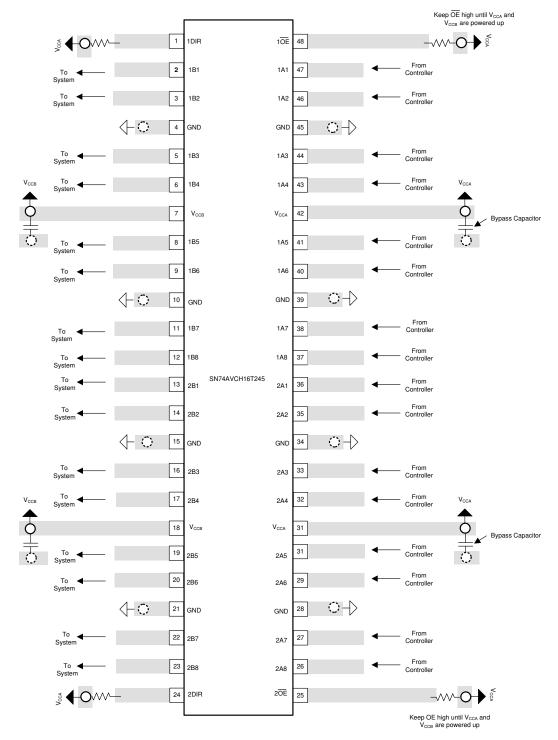


Figure 9-3. Recommended Layout Example



10 Device and Documentation Support

10.1 Documentation Support

10.1.1 Related Documentation

For related documentation see the following:

- CMOS Power Consumption and Cpd Calculation, SCAA035
- Implications of Slow or Floating CMOS Inputs, SCBA004

10.1.2 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.

10.2 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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10.4 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.

10.5 Glossary

TI Glossary

This glossary lists and explains terms, acronyms, and definitions.

11 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision E (July 2015) to Revision F (March 2024)	Page
Updated the numbering format for tables, figures, and cross-references throughout the document of the second	cument4
Changes from Revision D (February 2015) to Revision E (July 2015)	Page
Updated Pin Functions Table.	
Changes from Revision C (August 2005) to Revision D (February 2015)	Pag

Implementation section, Power Supply Recommendations section, Layout section, Device and Documentation Support section, and Mechanical, Packaging, and Orderable Information section1

Added ESD Ratings table, Feature Description section, Device Functional Modes, Application and

Product Folder Links: SN74AVC16T245



12 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.

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PACKAGING INFORMATION

Orderable part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking
	(1)	(2)			(3)	(4)	(5)		(6)
74AVC16T245DGGRG4	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
74AVC16T245DGGRG4.B	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
74AVC16T245DGVRE4	Active	Production	TVSOP (DGV) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	WF245
AVC16T245DGGR-D	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
SN74AVC16T245DGG	Active	Production	TSSOP (DGG) 48	40 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
SN74AVC16T245DGG.B	Active	Production	TSSOP (DGG) 48	40 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
SN74AVC16T245DGGR	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
SN74AVC16T245DGGR.B	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16T245
SN74AVC16T245DGVR	Active	Production	TVSOP (DGV) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	WF245
SN74AVC16T245DGVR.B	Active	Production	TVSOP (DGV) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	WF245

⁽¹⁾ Status: For more details on status, see our product life cycle.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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⁽²⁾ Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

⁽⁴⁾ Lead finish/Ball material: Parts 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.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

PACKAGE OPTION ADDENDUM

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OTHER QUALIFIED VERSIONS OF SN74AVC16T245:

Automotive: SN74AVC16T245-Q1

NOTE: Qualified Version Definitions:

• Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

PACKAGE MATERIALS INFORMATION

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TAPE AND REEL INFORMATION





A0	Dimension designed to accommodate the component width
В0	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		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
74AVC16T245DGGRG4	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74AVC16T245DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74AVC16T245DGVR	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	16.0	Q1

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*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
74AVC16T245DGGRG4	TSSOP	DGG	48	2000	356.0	356.0	45.0
SN74AVC16T245DGGR	TSSOP	DGG	48	2000	356.0	356.0	45.0
SN74AVC16T245DGVR	TVSOP	DGV	48	2000	353.0	353.0	32.0

PACKAGE MATERIALS INFORMATION

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TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
SN74AVC16T245DGG	DGG	TSSOP	48	40	530	11.89	3600	4.9
SN74AVC16T245DGG.B	DGG	TSSOP	48	40	530	11.89	3600	4.9



SMALL OUTLINE PACKAGE



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.

 3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
- exceed 0.15 mm per side.
 4. Reference JEDEC registration MO-153.



SMALL OUTLINE PACKAGE



NOTES: (continued)

- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SMALL OUTLINE PACKAGE



NOTES: (continued)

- 7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
- 8. Board assembly site may have different recommendations for stencil design.



DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



NOTES: A. All linear dimensions are in millimeters.

B. This drawing is subject to change without notice.

C. Body dimensions do not include mold protrusion not to exceed 0,15.

D. Falls within JEDEC MO-153

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