

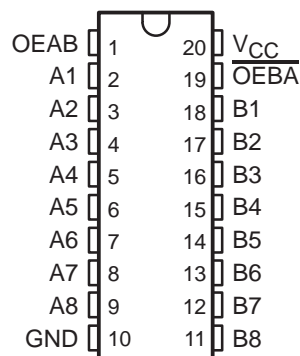
# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

SDAS226A – DECEMBER 1982 – REVISED JANUARY 1995

- Local Bus-Latch Capability
- Choice of True or Inverting Logic
- Package Options Include Plastic Small-Outline (DW) Packages and Standard Plastic (N) 300-mil DIPs

DEVICE	OUTPUT	LOGIC
SN74ALS620A	3 state	Inverting
SN74ALS621A	Open collector	True
SN74ALS623A, SN74AS623	3 state	True

DW OR N PACKAGE  
(TOP VIEW)



## description

These octal bus transceivers are designed for asynchronous two-way communication between data buses. The control-function implementation allows for maximum flexibility in timing.

These devices allow data transmission from the A bus to the B bus or from the B bus to the A bus, depending upon the logic levels at the output-enable (OEAB and  $\overline{\text{OEBA}}$ ) inputs.

The output-enable inputs disable the device so that the buses are effectively isolated. The dual-enable configuration gives the transceivers the capability to store data by simultaneously enabling OEAB and  $\overline{\text{OEBA}}$ . Each output reinforces its input in this transceiver configuration. When both OEAB and  $\overline{\text{OEBA}}$  are enabled and all other data sources to the two sets of bus lines are in the high-impedance state, both sets of bus lines (16 total) remain at their last states. The 8-bit codes appearing on the two sets of buses are identical for the SN74ALS621A, SN74ALS623A, and SN74AS623 or complementary for the SN74ALS620A.

The -1 versions of the SN74ALS620A and SN74ALS621A are identical to the standard versions, except that the recommended maximum  $I_{OL}$  is increased to 48 mA in the -1 versions.

The SN74ALS620A, SN74ALS621A, SN74ALS623A, and SN74AS623 are characterized for operation from 0°C to 70°C.

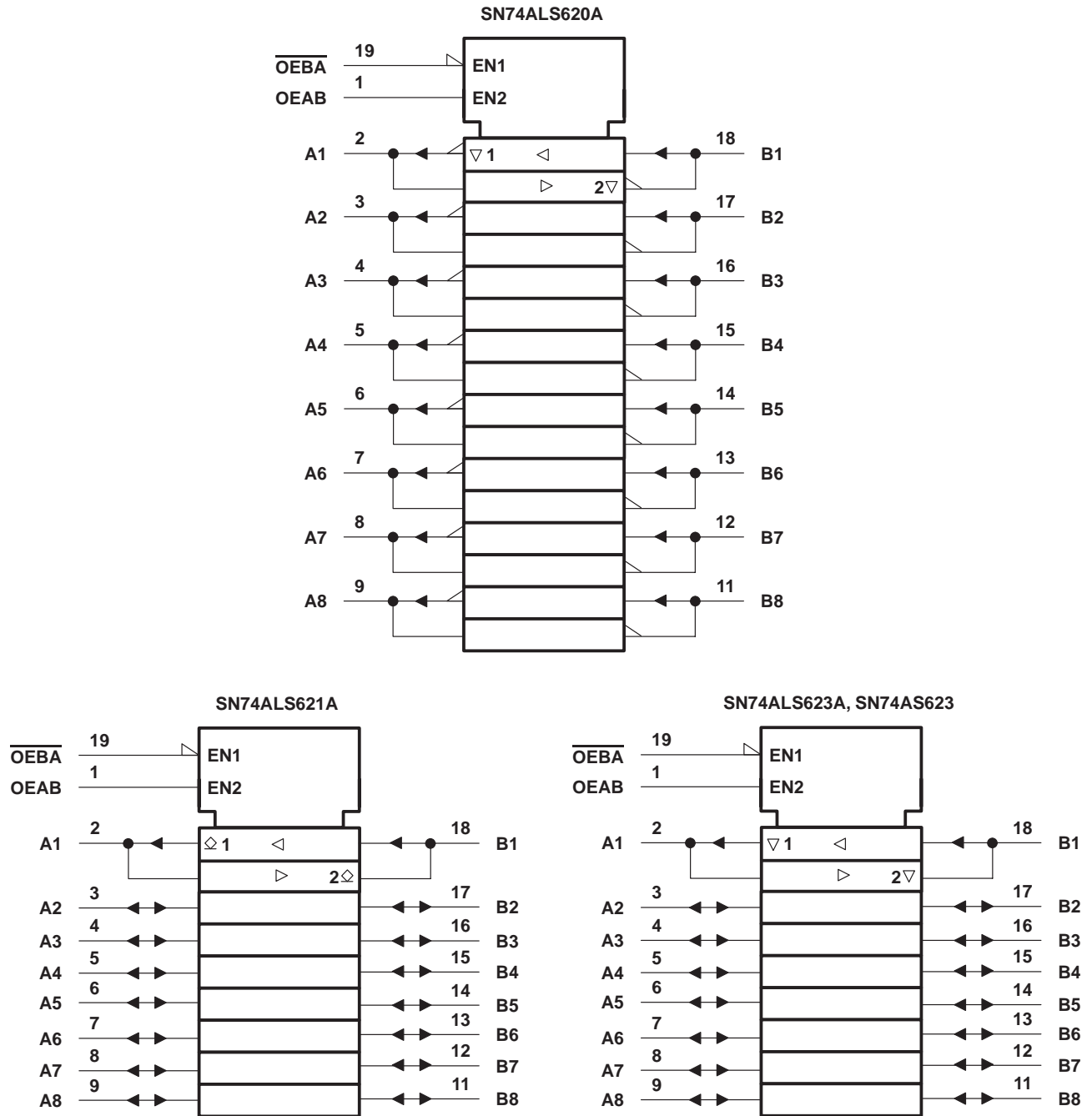
FUNCTION TABLE

INPUTS		OPERATION	
$\overline{\text{OEBA}}$	OEAB	SN74ALS620A	SN74ALS621A SN74ALS623A SN74AS623
L	L	$\overline{\text{B}}$ data to A bus	B data to A bus
H	H	$\overline{\text{A}}$ data to B bus	A data to B bus
H	L	Isolation	Isolation
L	H	$\overline{\text{B}}$ data to A bus, $\overline{\text{A}}$ data to B bus	B data to A bus, A data to B bus

# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

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## logic symbols†

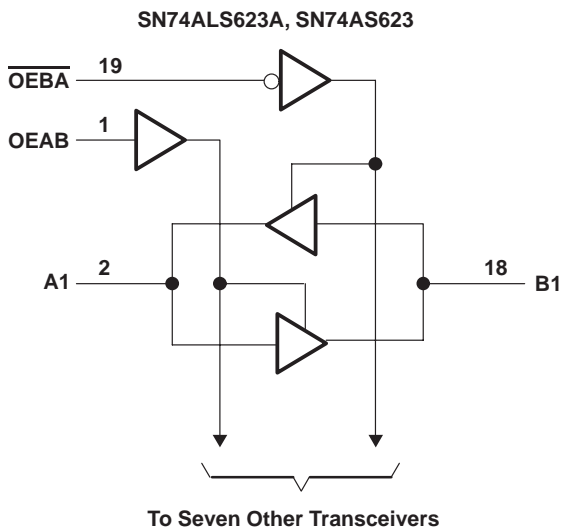
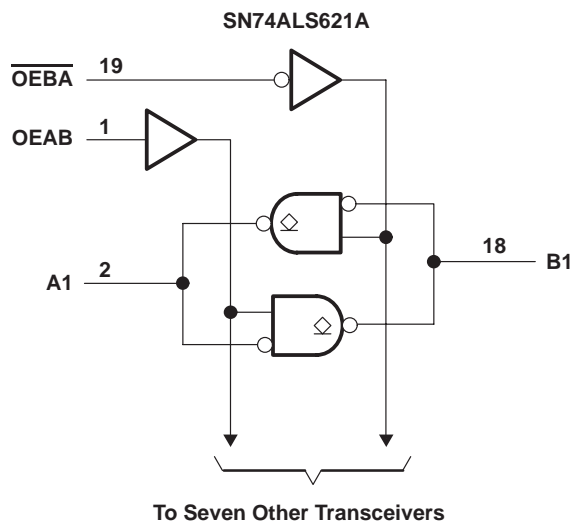
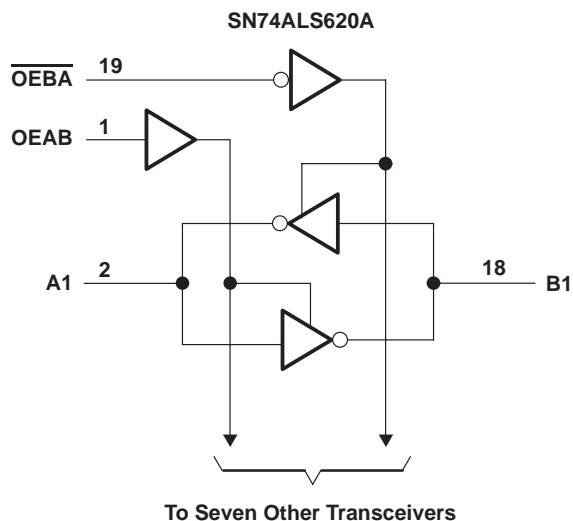


† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

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## logic diagrams (positive logic)



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC}$ .....	7 V
Input voltage, $V_I$ : All inputs .....	7 V
I/O ports .....	5.5 V
Operating free-air temperature range, $T_A$ : SN74ALS620A, SN74ALS623A .....	0°C to 70°C
Storage temperature range .....	-65°C to 150°C

† 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.

# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

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## recommended operating conditions

		SN74ALS620A SN74ALS623A			UNIT
		MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			V
$V_{IL}$	Low-level input voltage			0.8	V
$I_{OH}$	High-level output current			-15	mA
$I_{OL}$	Low-level output current			24	mA
$T_A$	Operating free-air temperature	0		70	°C

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN74ALS620A SN74ALS623A		UNIT
				MIN	TYP†	
$V_{IK}$		$V_{CC} = 4.5\text{ V}$ ,	$I_I = -18\text{ mA}$		-1.2	V
$V_{OH}$		$V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ ,	$I_{OH} = -0.4\text{ mA}$	$V_{CC} - 2$		V
		$V_{CC} = 4.5\text{ V}$	$I_{OH} = -3\text{ mA}$	2.4	3.2	
			$I_{OH} = -15\text{ mA}$	2		
$V_{OL}$		$V_{CC} = 4.5\text{ V}$	$I_{OL} = 12\text{ mA}$	0.25	0.4	V
			$I_{OL} = 24\text{ mA}^\ddagger$	0.35	0.5	
$I_I$	Control inputs	$V_{CC} = 5.5\text{ V}$	$V_I = 7\text{ V}$		0.1	mA
	A or B ports		$V_I = 5.5\text{ V}$		0.1	
$I_{IH}$	Control inputs	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 2.7\text{ V}$		20	$\mu\text{A}$
	A or B ports§				20	
$I_{IL}$	Control inputs	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 0.4\text{ V}$		-0.1	mA
	A or B ports§				-0.1	
$I_{O}^\parallel$		$V_{CC} = 5.5\text{ V}$ ,	$V_O = 2.25\text{ V}$	-30	-112	mA
$I_{CC}$	SN74ALS620A	$V_{CC} = 5.5\text{ V}$	Outputs high	24	34	mA
			Outputs low	31	44	
			Outputs disabled	33	47	
	SN74ALS623A	$V_{CC} = 5.5\text{ V}$	Outputs high	32	43	
			Outputs low	39	50	
			Outputs disabled	42	55	

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

‡ Applies only to the -1 version and only if  $V_{CC}$  is between 4.75 V and 5.25 V

§ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

¶ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current,  $I_{OS}$ .

# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

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## switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†				UNIT
			SN74ALS620A		SN74ALS623A		
			MIN	MAX	MIN	MAX	
t <sub>PLH</sub>	A	B	2	10	2	13	ns
t <sub>PHL</sub>			2	10	3	11	
t <sub>PLH</sub>	B	A	2	10	2	13	ns
t <sub>PHL</sub>			2	10	3	11	
t <sub>PZH</sub>	$\overline{\text{OEBA}}$	A	3	17	5	22	ns
t <sub>PZL</sub>			5	25	5	22	
t <sub>PHZ</sub>	$\overline{\text{OEBA}}$	A	2	12	2	16	ns
t <sub>PLZ</sub>			3	18	2	19	
t <sub>PZH</sub>	OEAB	B	3	18	5	22	ns
t <sub>PZL</sub>			5	25	5	22	
t <sub>PHZ</sub>	OEAB	B	2	12	2	16	ns
t <sub>PLZ</sub>			3	18	2	19	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡

Supply voltage, V <sub>CC</sub>	7 V
Input voltage, V <sub>I</sub> : All inputs and I/O ports	7 V
Operating free-air temperature range, T <sub>A</sub> : SN74ALS621A	0°C to 70°C
Storage temperature range	-65°C to 150°C

‡ 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.

## recommended operating conditions

		SN74ALS621A			UNIT
		MIN	NOM	MAX	
V <sub>CC</sub>	Supply voltage	4.5	5	5.5	V
V <sub>IH</sub>	High-level input voltage	2			V
V <sub>IL</sub>	Low-level input voltage			0.8	V
V <sub>OH</sub>	High-level output voltage			5.5	V
I <sub>OL</sub>	Low-level output current			24	mA
				48§	mA
T <sub>A</sub>	Operating free-air temperature	0		70	°C

§ Applies only to the -1 version and only if V<sub>CC</sub> is between 4.75 V and 5.25 V



# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

SDAS226A – DECEMBER 1982 – REVISED JANUARY 1995

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	SN74ALS621A			UNIT
			MIN	TYP†	MAX	
V <sub>IK</sub>		V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = -18 mA	-1.5			V
I <sub>OH</sub>		V <sub>CC</sub> = 4.5 V, V <sub>OH</sub> = 5.5 V	0.1			mA
V <sub>OL</sub>		V <sub>CC</sub> = 4.5 V	I <sub>OL</sub> = 24 mA		0.35	0.5
			I <sub>OL</sub> = 48 mA‡		0.35	0.5
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 5.5 V	V <sub>I</sub> = 7 V		0.1	
	A or B ports		V <sub>I</sub> = 5.5 V		0.1	
I <sub>IH</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V	20			μA
	A or B ports§		20			
I <sub>IL</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V	-0.1			mA
	A or B ports§		-0.1			
I <sub>CC</sub>		V <sub>CC</sub> = 5.5 V	Outputs high		29	40
			Outputs low		35	48

† All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

‡ Applies only to the -1 version and only if V<sub>CC</sub> is between 4.75 V and 5.25 V

§ For I/O ports, the parameters I<sub>IH</sub> and I<sub>IL</sub> include the off-state output current.

## switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>L</sub> = 680 Ω, T <sub>A</sub> = MIN to MAX††		UNIT
			SN74ALS621A		
			MIN	MAX	
t <sub>PLH</sub>	A	B	10	33	ns
t <sub>PHL</sub>			5	20	
t <sub>PLH</sub>	B	A	10	33	ns
t <sub>PHL</sub>			5	20	
t <sub>PLH</sub>	$\overline{\text{OEBA}}$	A	10	39	ns
t <sub>PHL</sub>			12	35	
t <sub>PLH</sub>	OEAB	B	10	39	ns
t <sub>PHL</sub>			12	35	

†† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.



# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC}$ .....	7 V
Input voltage, $V_I$ : All inputs .....	7 V
I/O ports .....	5.5 V
Operating free-air temperature range, $T_A$ : SN74AS623 .....	0°C to 70°C
Storage temperature range .....	–65°C to 150°C

† 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.

## recommended operating conditions

		SN74AS623			UNIT
		MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			V
$V_{IL}$	Low-level input voltage			0.8	V
$I_{OH}$	High-level output current			–15	mA
$I_{OL}$	Low-level output current			64	mA
$T_A$	Operating free-air temperature	0		70	°C

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN74AS623		UNIT
				MIN	TYP‡	
$V_{IK}$		$V_{CC} = 4.5\text{ V}$ ,	$I_I = -18\text{ mA}$		–1.2	V
$V_{OH}$		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ,	$I_{OH} = -2\text{ mA}$	$V_{CC} - 2$		V
		$V_{CC} = 4.5\text{ V}$	$I_{OH} = -3\text{ mA}$	2.4	3.2	
			$I_{OH} = -15\text{ mA}$	2		
$V_{OL}$		$V_{CC} = 4.5\text{ V}$ ,	$I_{OL} = 64\text{ mA}$	0.35	0.55	V
$I_I$	Control inputs	$V_{CC} = 5.5\text{ V}$	$V_I = 7\text{ V}$	0.1		mA
	A or B ports		$V_I = 5.5\text{ V}$	0.1		
$I_{IH}$	Control inputs	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 2.7\text{ V}$	20		µA
	A or B ports§			70		
$I_{IL}$	Control inputs	$V_{CC} = 5.5\text{ V}$ ,	$V_I = 0.4\text{ V}$	–0.5		mA
	A or B ports§			–0.75		
$I_{O}¶$		$V_{CC} = 5.5\text{ V}$ ,	$V_O = 2.25\text{ V}$	–30	–150	mA
$I_{CC}$		$V_{CC} = 5.5\text{ V}$	Outputs high	57	93	mA
			Outputs low	16	189	
			Outputs disabled	71	116	

‡ All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

§ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

¶ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current,  $I_{OS}$ .



# SN74ALS620A, SN74ALS621A, SN74ALS623A, SN74AS623 OCTAL BUS TRANSCEIVERS

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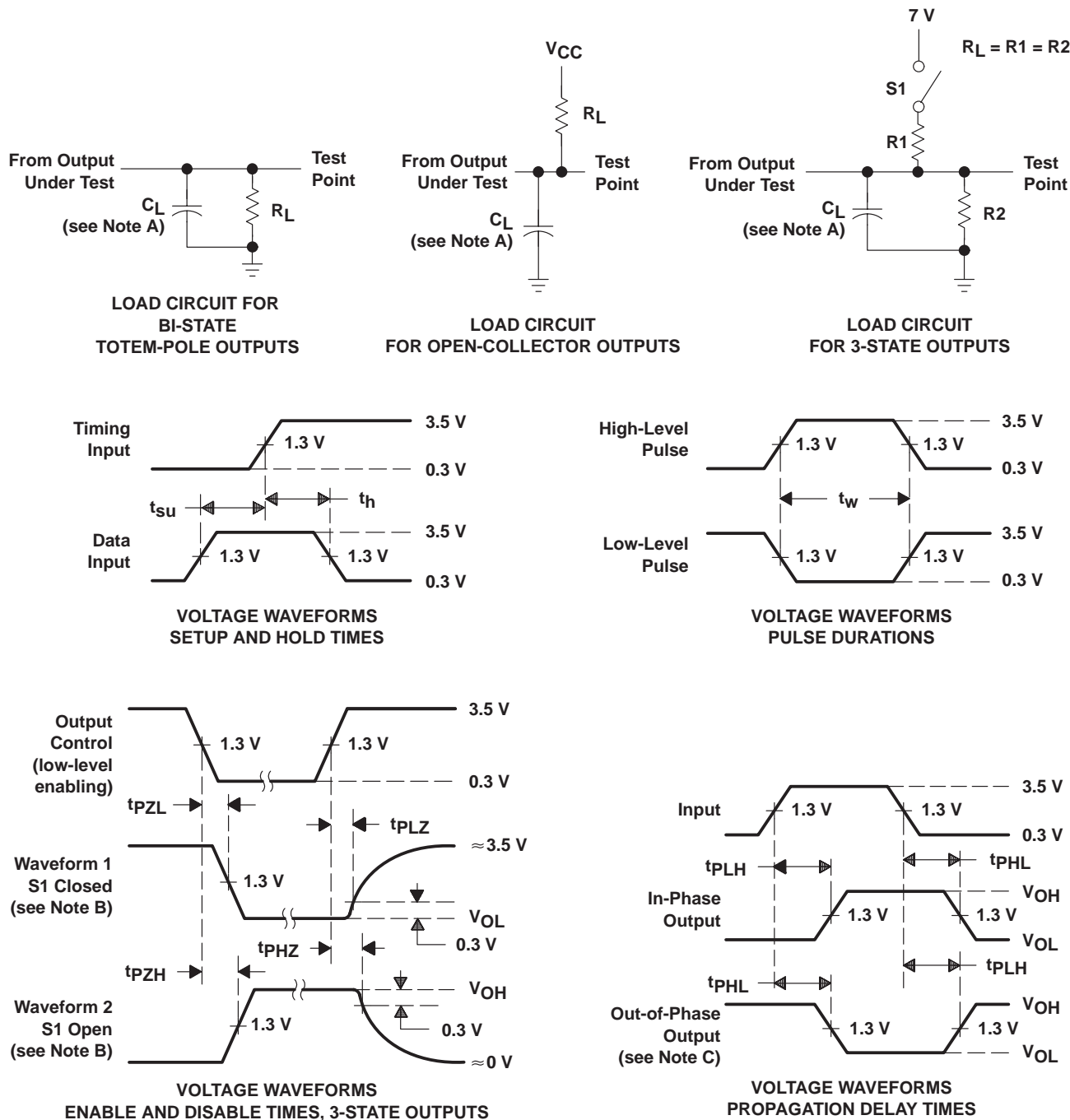
## switching characteristics (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†		UNIT
			SN74AS623		
			MIN	MAX	
t <sub>PLH</sub>	A	B	1	9	ns
t <sub>PHL</sub>			1	8	
t <sub>PLH</sub>	B	A	1	9	ns
t <sub>PHL</sub>			1	8.5	
t <sub>PZH</sub>	$\overline{\text{OEBA}}$	A	2	11	ns
t <sub>PZL</sub>			2	10	
t <sub>PHZ</sub>	$\overline{\text{OEBA}}$	A	1	7.5	ns
t <sub>PLZ</sub>			1	11.5	
t <sub>PZH</sub>	OEAB	B	2	11.5	ns
t <sub>PZL</sub>			2	11	
t <sub>PHZ</sub>	OEAB	B	1	7	ns
t <sub>PLZ</sub>			1	9	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.



PARAMETER MEASUREMENT INFORMATION  
SERIES 54ALS/74ALS AND 54AS/74AS DEVICES



- 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. When measuring propagation delay items of 3-state outputs, switch S1 is open.  
 D. All input pulses have the following characteristics:  $PRR \leq 1$  MHz,  $t_r = t_f = 2$  ns, duty cycle = 50%.  
 E. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

**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
SN74ALS620ADW	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS620A	Samples
SN74ALS620AN	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74ALS620AN	Samples
SN74ALS621A-1N	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74ALS621A-1N	Samples
SN74ALS621ADW	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS621A	Samples
SN74ALS621AN	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74ALS621AN	Samples
SN74ALS623ADW	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS623A	Samples
SN74ALS623AN	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN74ALS623AN	Samples
SN74ALS623ANSR	ACTIVE	SOP	NS	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	ALS623A	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) **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.

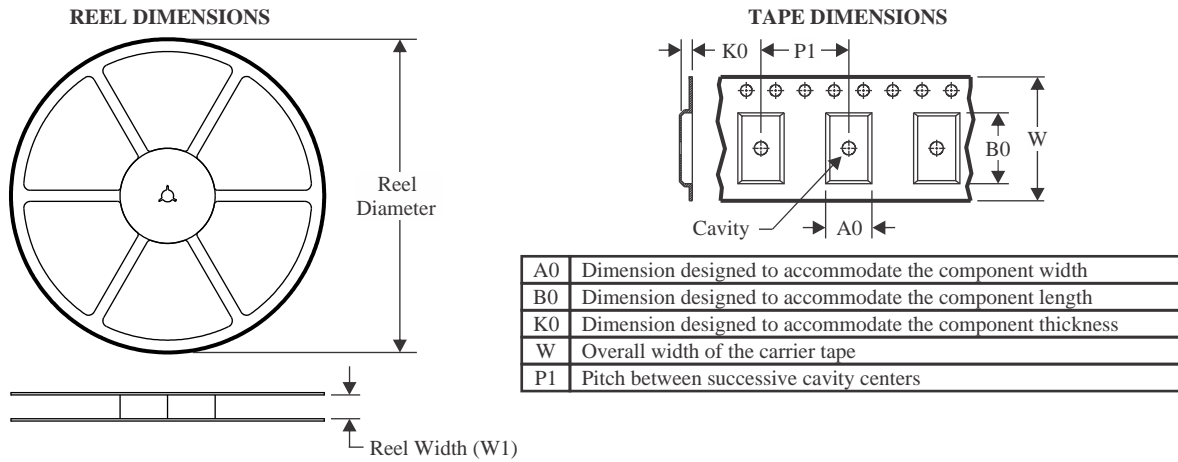
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

<sup>(6)</sup> 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**

**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
SN74ALS623ANSR	SOP	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	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)
SN74ALS623ANSR	SOP	NS	20	2000	367.0	367.0	45.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74ALS620ADW	DW	SOIC	20	25	507	12.83	5080	6.6
SN74ALS620AN	N	PDIP	20	20	506	13.97	11230	4.32
SN74ALS621A-1N	N	PDIP	20	20	506	13.97	11230	4.32
SN74ALS621ADW	DW	SOIC	20	25	507	12.83	5080	6.6
SN74ALS621AN	N	PDIP	20	20	506	13.97	11230	4.32
SN74ALS623ADW	DW	SOIC	20	25	507	12.83	5080	6.6
SN74ALS623AN	N	PDIP	20	20	506	13.97	11230	4.32

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-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 flash or protrusion, not to exceed 0,15.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - △ Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - ⊕ The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002



# DW0020A



# PACKAGE OUTLINE

## SOIC - 2.65 mm max height

SOIC



4220724/A 05/2016

**NOTES:**

1. All linear dimensions are in millimeters. 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. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.

# EXAMPLE BOARD LAYOUT

DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

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

# EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:6X

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NOTES: (continued)

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

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