SN74AHC132 Quadruple Positive-NAND Gates with Schmitt-Trigger Inputs

1 Features

- Operating Range 2-V to 5.5-V V_{CC}
- Operation From Very Slow Input Transitions
- Temperature-Compensated Threshold Levels
- High Noise Immunity
- Same Pinouts as SNx4AHC00
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model
  - 200-V Machine Model
  - 1000-V Charged-Device Model

2 Applications

- Electronic Points of Sale
- Telecom Infrastructure
- Network Switches
- Tests and Measurements

3 Description

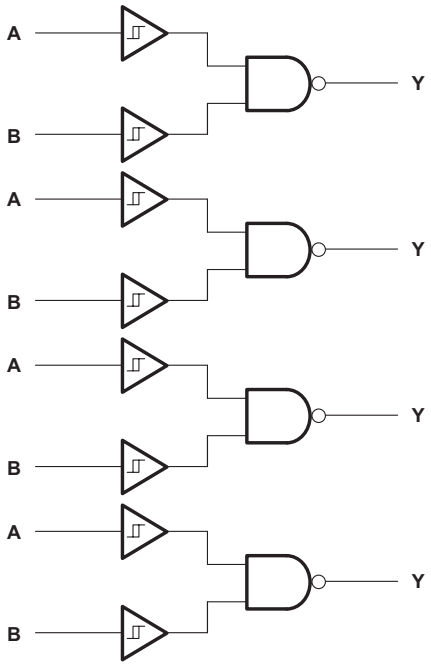
The SN7AHC132 device is a quadruple positive-NAND gate designed for 2-V to 5.5-V V_{CC} operation. This device performs the Boolean function $Y = \overline{A \times B}$ or $Y = \overline{A} + \overline{B}$ in positive logic.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SNx4AHC132	SOIC (14)	8.65 mm × 3.91 mm
	SSOP (14)	6.20 mm x 5.30 mm
	TVSOP (14)	3.60 mm x 4.40 mm
	TSSOP (14)	5.00 mm x 4.40 mm
	VQFN (14)	3.50 mm x 3.50 mm

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

4 Simplified Schematic



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- Deleted Ordering Information table. ... 1
- Deleted SN54AHC132 device from data sheet. ... 1
- Added Applications. ... 1
- Added Pin Functions table. ... 3
- Added Handling Ratings table. ... 4
- Changed MAX operating temperature to 125°C in Recommended Operating Conditions table. ... 4
- Added Thermal Information table. ... 4
- Added –40°C to 125°C range for SN74AHC132 in Electrical Characteristics table. ... 4
- Added T_A = –40°C to 125°C for SN74AHC132 in both Switching Characteristics tables. ... 5
- Added Typical Characteristics. ... 6
- Added Detailed Description section. ... 8
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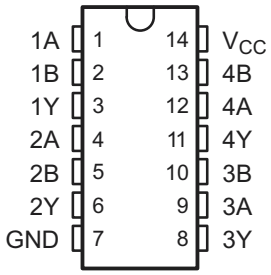
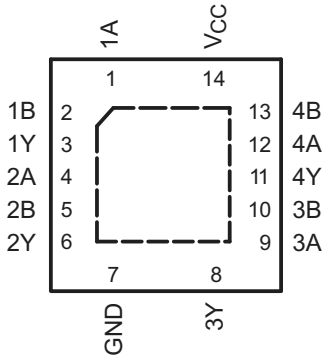
6 Pin Configuration and Functions

SN74AHC132 . . . D, DB, DGV, N, NS, OR PW PACKAGE (TOP VIEW)



SN74AHC132 . . . RGY PACKAGE (TOP VIEW)



Pin Functions

PIN		I/O	DESCRIPTION
NAME	SN74AHC132 D, DB, DGV, N, NS, PW, RGY		
1A	1	I	1A Input
1B	2	I	1B Input
1Y	3	O	1Y Output
2A	4	I	2A Input
2B	5	I	2B Input
2Y	6	O	2Y Output
3Y	8	O	3Y Output
3A	9	I	3A Input
3B	10	I	3B Input
4Y	11	O	4Y Output
4A	12	I	4A Input
4B	13	I	4B Input
GND	7	—	Ground Pin
V_{CC}	14	—	Power Pin

7 Specifications

7.1 Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	7	V
V_I	Input voltage range(2)		–0.5	7	V
V_O	Output voltage range(2)		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	V_I < 0		–20	mA
I_{OK}	Output clamp current	V_O < 0 or V_O > V_{CC}		±20	mA
I_O	Continuous output current	V_O = 0 to V_{CC}		±25	mA
	Continuous current through V_{CC} or GND			±50	mA

(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 and output voltage ratings may be exceeded if the input and output current ratings are observed.

7.2 Handling Ratings

			MIN	MAX	UNIT
T_{stg}	Storage temperature range		–65	150	°C
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	0	2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2)	0	1000	

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

7.3 Recommended Operating Conditions

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

			SN74AHC132		UNIT
			MIN	MAX	
V_{CC}	Supply voltage		2	5.5	V
V_I	Input voltage		0	5.5	V
V_O	Output voltage		0	V_{CC}	V
I_{OH}	High-level output current	V_{CC} = 2 V		–50	μA
		V_{CC} = 3.3 V ± 0.3 V		–4	mA
		V_{CC} = 5 V ± 0.5 V		–8	
I_{OL}	Low-level output current	V_{CC} = 2 V		50	μA
		V_{CC} = 3.3 V ± 0.3 V		4	mA
		V_{CC} = 5 V ± 0.5 V		8	
T_A	Operating free-air temperature		–40	125	°C

(1) All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs* (SCBA004).

7.4 Thermal Information

THERMAL METRIC(1)		SN74AHC132							UNIT
		D	DB	DR	N	NS	PW	RGY	
		14 PINS							
$R_{\theta JA}$	Junction-to-ambient thermal resistance	90.6	107.1	90.6	57.4	90.7	122.6	57.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	50.9	59.6	50.9	44.9	48.3	51.4	57.5	
$R_{\theta JB}$	Junction-to-board thermal resistance	44.8	54.4	44.8	37.2	49.4	64.4	33.6	
ψ_{JT}	Junction-to-top characterization parameter	14.7	20.5	14.7	30.1	14.6	6.7	3.4	
ψ_{JB}	Junction-to-board characterization parameter	44.5	53.8	44.5	37.1	49.1	63.8	33.7	
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	—	—	—	—	13.9	

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

7.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V_{CC}	T_A = 25°C			SN74AHC132		–40°C to 125°C SN74AHC132		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{T+} Positive-going input threshold voltage		3 V	1.2		2.2	1.2	2.2	1.2	2.2	V
		4.5 V	1.75		3.15	1.75	3.15	1.75	3.15	
		5.5 V	2.15		3.85	2.15	3.85	2.15	3.85	

Electrical Characteristics (continued)

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

PARAMETER	TEST CONDITIONS	V_{CC}	T_A = 25°C			SN74AHC132		–40°C to 125°C SN74AHC132		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{T-} Negative-going input threshold voltage		3 V	0.9		1.9	0.9	1.9	0.9	1.9	V
		4.5 V	1.35		2.75	1.35	2.75	1.35	2.75	
		5.5 V	1.65		3.35	1.65	3.35	1.65	3.35	
ΔV_T Hysteresis ($V_{T+} - V_{T-}$)		3 V	0.3		1.2	0.3	1.2	0.3	1.2	V
		4.5 V	0.4		1.4	0.4	1.4	0.4	1.4	
		5.5 V	0.5		1.6	0.5	1.6	0.5	1.6	
V_{OH}	I_{OH} = –50 µA	2 V	1.9	2		1.9		1.9		V
		3 V	2.9	3		2.9		2.9		
		4.5 V	4.4	4.5		4.4		4.4		
	I_{OH} = –4 mA	3 V	2.58			2.48		2.48		
	I_{OH} = –8 mA	4.5 V	3.94			3.8		3.8		
V_{OL}	I_{OL} = 50 µA	2 V			0.1		0.1		0.1	V
		3 V			0.1		0.1		0.1	
		4.5 V			0.1		0.1		0.1	
	I_{OL} = 4 mA	3 V			0.36		0.44		0.44	
	I_{OL} = 8 mA	4.5 V			0.36		0.44		0.44	
I_I	V_I = 5.5 V or GND	0 V to 5.5 V			±0.1		±1		±1	µA
I_{CC}	$V_I = V_{CC}$ or GND, I_O = 0	5.5 V			2		20		20	µA
C_i	$V_I = V_{CC}$ or GND	5 V		1.9	10		10		10	pF

7.6 Switching Characteristics, V_{CC} = 3.3 V ± 0.3 V

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			SN74AHC132		T_A = –40°C to 125°C SN74AHC132		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A or B	Y	C_L = 15 pF		5.6(1)	11.9(1)	1	14	1	15	ns
t_{PHL}					5.6(1)	11.9(1)	1	14	1	15	
t_{PLH}	A or B	Y	C_L = 50 pF		7.6	15.4	1	17.5	1	19	ns
t_{PHL}					7.6	15.4	1	17.5	1	19	

(1) On products compliant to MIL-PRF-38535, this parameter is not production tested.

7.7 Switching Characteristics, V_{CC} = 5 V ± 0.5 V

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			SN74AHC132		T_A = –40°C to 125°C SN74AHC132		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A or B	Y	C_L = 15 pF		3.9(1)	7.7(1)	1	9	1	10	ns
t_{PHL}					3.9(1)	7.7(1)	1	9	1	10	
t_{PLH}	A or B	Y	C_L = 50 pF		5.3	9.7	1	11	1	12	ns
t_{PHL}					5.3	9.7	1	11	1	12	

(1) On products compliant to MIL-PRF-38535, this parameter is not production tested.

7.8 Noise Characteristics

V_{CC} = 5 V, C_L = 50 pF, T_A = 25°C(1)

(1) Characteristics are for surface-mount packages only.

Noise Characteristics (continued)

V_{CC} = 5 V, C_L = 50 pF, T_A = 25°C(1)

PARAMETER		SN74AHC132			UNIT
		MIN	TYP	MAX	
$V_{OL(P)}$	Quiet output, maximum dynamic V_{OL}		0.45	0.8	V
$V_{OL(V)}$	Quiet output, minimum dynamic V_{OL}		–0.35	–0.8	V
$V_{OH(V)}$	Quiet output, minimum dynamic V_{OH}		4.8		V
$V_{IH(D)}$	High-level dynamic input voltage	3.5			V
$V_{IL(D)}$	Low-level dynamic input voltage			1.5	V

7.9 Operating Characteristics

V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TYP	UNIT
C_{pd}	Power dissipation capacitance	No load,	f = 1 MHz	11	pF

7.10 Typical Characteristics

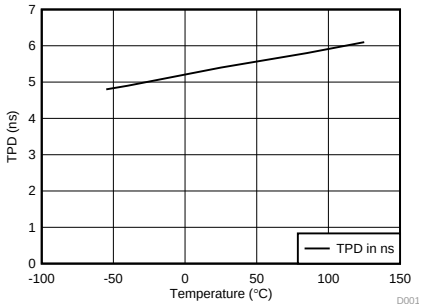


Figure 1. TPD vs Temperature

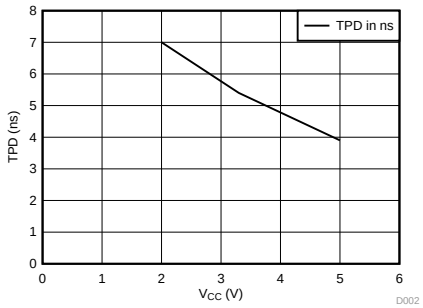
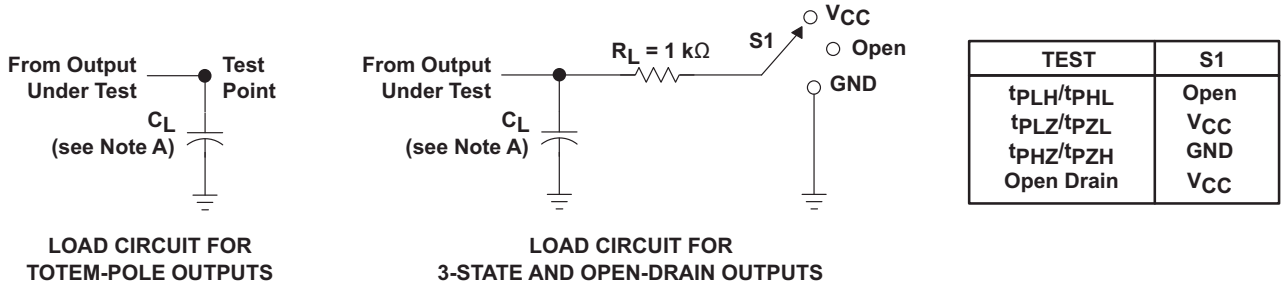


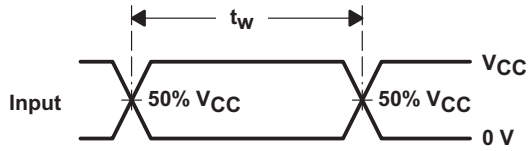
Figure 2. TPD vs V_{CC}

8 Parameter Measurement Information

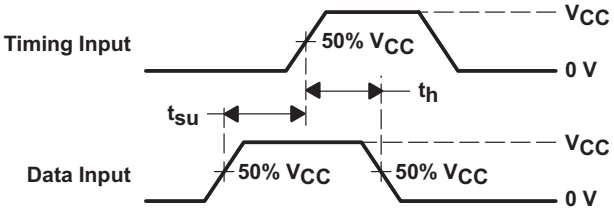


LOAD CIRCUIT FOR TOTEM-POLE OUTPUTS

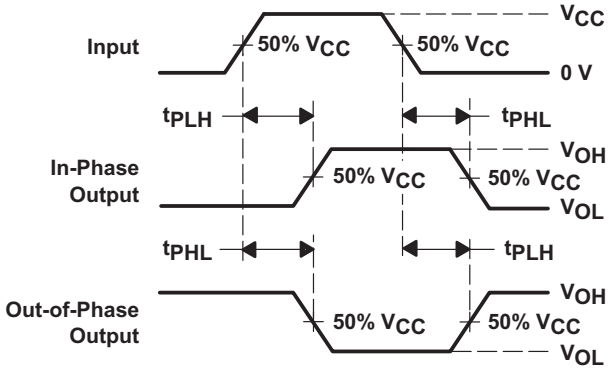
LOAD CIRCUIT FOR 3-STATE AND OPEN-DRAIN OUTPUTS



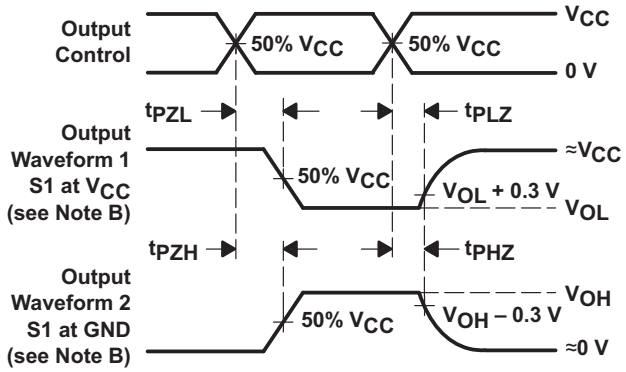
VOLTAGE WAVEFORMS PULSE DURATION



VOLTAGE WAVEFORMS SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES LOW- AND HIGH-LEVEL ENABLING

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 ≤ 1 MHz, Z_O = 50 Ω, t_r ≤ 3 ns, t_f ≤ 3 ns.
D. The outputs are measured one at a time with one input transition per measurement.
E. All parameters and waveforms are not applicable to all devices.

Figure 3. Load Circuit and Voltage Waveforms

9 Detailed Description

9.1 Overview

The SN74AHC132 is a quadruple 2-input positive-NAND gate with low drive that produces slow rise and fall times. This reduces ringing on the output signal.

Each circuit functions as a NAND gate, but because of the Schmitt action, it has different input threshold levels for positive- and negative-going signals.

These circuits are temperature compensated and can be triggered from the slowest of input ramps and still give clean, jitter-free output signals.

9.2 Functional Block Diagram

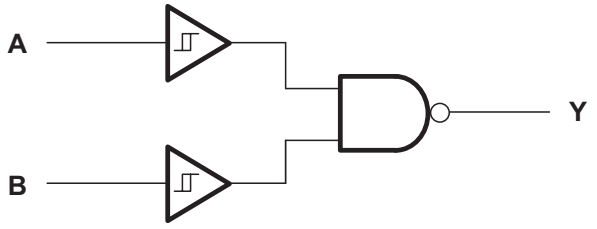


Figure 4. Logic Diagram, Each Gate (Positive Logic)

9.3 Feature Description

- Wide operating voltage range
  - Operates from 2 V to 5.5 V
- Allows down voltage translation
  - Inputs accept voltages to 5.5 V

9.4 Device Functional Modes

Table 1. Function Table (Each Gate)

INPUTS		OUTPUT Y
A	B	
H	H	L
L	X	H
X	L	H

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 SN74AHC132 is a low-drive CMOS device that can be used for a multitude of bus interface type applications where output ringing is a concern. The low drive and slow edge rates will minimize overshoot and undershoot on the outputs. The inputs can accept voltages to 5.5 V at any valid V_{CC}, thus making the device ideal for down translation.

10.2 Typical Application

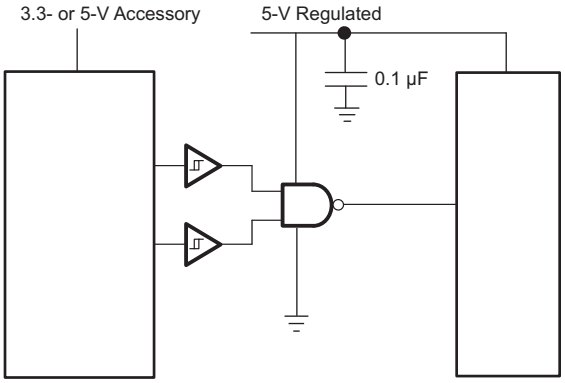


Figure 5. Typical Application Schematic

10.2.1 Design Requirements

This device uses CMOS technology and has balanced output drive. Care should be taken to avoid bus contention because it can drive currents that would exceed maximum limits. The high drive will also create fast edges into light loads, so routing and load conditions should be considered to prevent ringing.

10.2.2 Detailed Design Procedure

1. Recommended Input Conditions:
   - For rise time and fall time specifications, see Δt/ΔV in the *Recommended Operating Conditions* table.
   - For specified high and low levels, see V_{IH} and V_{IL} in the *Recommended Operating Conditions* table.
   - Inputs are overvoltage tolerant allowing them to go as high as 5.5 V at any valid V_{CC}.
2. Recommend Output Conditions:
   - Load currents should not exceed 25 mA per output and 50 mA total for the part.
   - Outputs should not be pulled above V_{CC}.

Typical Application (continued)

10.2.3 Application Curves

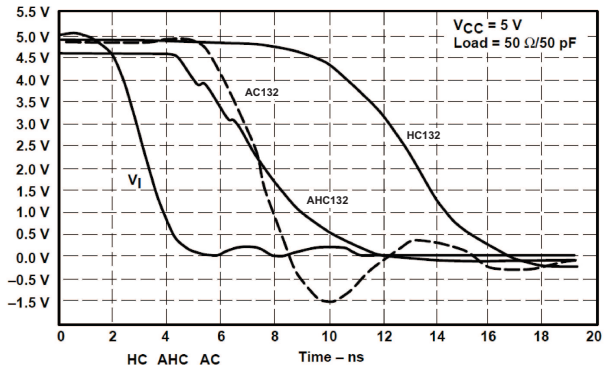


Figure 6. Switching Characteristics Comparison

11 Power Supply Recommendations

The power supply can be any voltage between the MIN and MAX supply-voltage rating located in the *Recommended Operating Conditions* table.

Each V_{CC} pin should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, 0.1µF is recommended. If there are multiple V_{CC} pins then a 0.01 µF or a 0.022 µF is recommended for each power pin. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. A 0.1 µF and a 1 µF are commonly used in parallel. The bypass capacitor should be installed as close to the power pin as possible for best results.

12 Layout

12.1 Layout Guidelines

When using multiple bit logic devices, inputs should not float. In many cases, functions or parts of functions of digital logic devices are unused. Some examples are when only two inputs of a triple-input AND gate are used, or when only 3 of the 4-buffer gates are used. Such input pins should not be left unconnected because the undefined voltages at the outside connections result in undefined operational states.

Specified in the Figure 7 are rules that must be observed under all circumstances. All unused inputs of digital logic devices must be connected to a high or low bias to prevent them from floating. The logic level that should be applied to any particular unused input depends on the function of the device. Generally they will be tied to GND or V_{CC}, whichever makes more sense or is more convenient. It is acceptable to float outputs unless the part is a transceiver. If the transceiver has an output enable pin, it will disable the outputs section of the part when asserted. This will not disable the input section of the I/Os so they also cannot float when disabled.

12.2 Layout Example

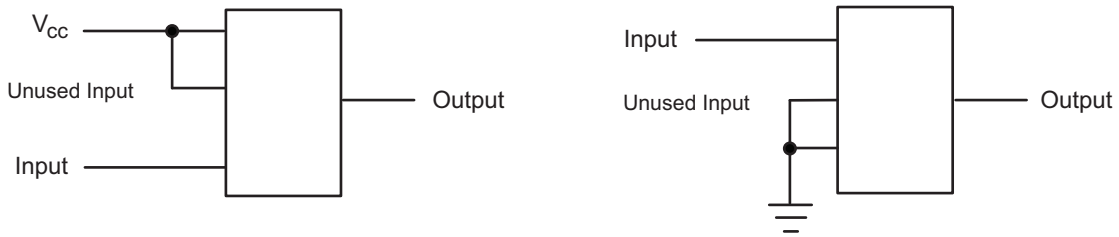


Figure 7. Layout Diagram

13 Device and Documentation Support

13.1 Trademarks

All trademarks are the property of their respective owners.

13.2 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

13.3 Glossary

SLYZ022 — *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
SN74AHC132D	ACTIVE	SOIC	D	14	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AHC132	Samples
SN74AHC132DBR	ACTIVE	SSOP	DB	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA132	Samples
SN74AHC132DGVR	ACTIVE	TVSOP	DGV	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA132	Samples
SN74AHC132DR	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AHC132	Samples
SN74AHC132DRE4	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AHC132	Samples
SN74AHC132N	ACTIVE	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 125	SN74AHC132N	Samples
SN74AHC132NSR	ACTIVE	SO	NS	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AHC132	Samples
SN74AHC132PW	ACTIVE	TSSOP	PW	14	90	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA132	Samples
SN74AHC132PWR	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA132	Samples
SN74AHC132PWRG4	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HA132	Samples
SN74AHC132RGYR	ACTIVE	VQFN	RGY	14	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	HA132	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.

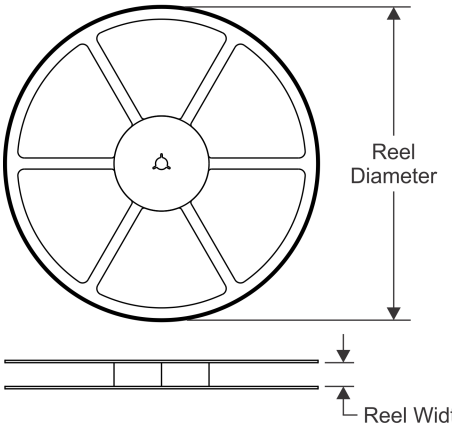
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

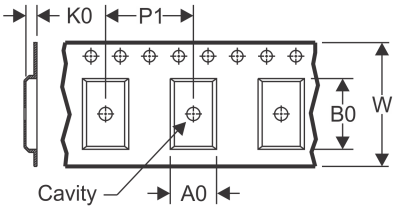
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

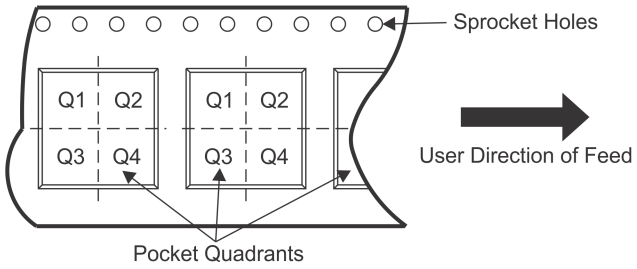


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

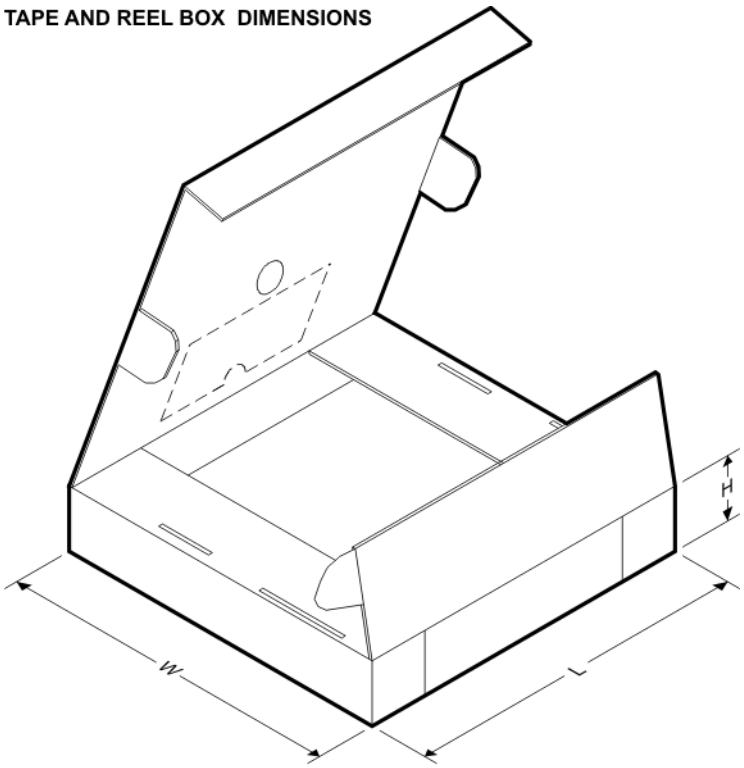
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AHC132DBR	SSOP	DB	14	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
SN74AHC132DGVR	TVSOP	DGV	14	2000	330.0	12.4	6.8	4.0	1.6	8.0	12.0	Q1
SN74AHC132DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
SN74AHC132NSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
SN74AHC132PWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN74AHC132RGYR	VQFN	RGY	14	3000	330.0	12.4	3.75	3.75	1.15	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AHC132DBR	SSOP	DB	14	2000	853.0	449.0	35.0
SN74AHC132DGVR	TVSOP	DGV	14	2000	853.0	449.0	35.0
SN74AHC132DR	SOIC	D	14	2500	853.0	449.0	35.0
SN74AHC132NSR	SO	NS	14	2000	853.0	449.0	35.0
SN74AHC132PWR	TSSOP	PW	14	2000	853.0	449.0	35.0
SN74AHC132RGYR	VQFN	RGY	14	3000	853.0	449.0	35.0

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