SN74LVC86A-Q1 Automotive Quadruple 2-Input Exclusive-OR Gate

1 Features

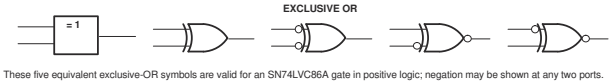
- Qualified for automotive applications
- ESD protection exceeds 2000V per MIL-STD-883, Method 3015
- Operates from 2V to 3.6V
- Inputs accept voltages to 5.5V
- Max t_{pd} of 4.6ns at 3.3V
- Typical V_{OLP} (output ground bounce) < 0.8V at V_{CC} = 3.3V, T_A = 25°C
- Typical V_{OHV} (output V_{OH} undershoot) > 2V at V_{CC} = 3.3V, T_A = 25°C

2 Description

The SN74LVC86A-Q1 quadruple 2-input exclusive-OR gate is designed for 2.7V to 3.6V V_{CC} operation.

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)	BODY SIZE(3)
SN74LVC86A-Q1	D (SOIC, 14)	8.65mm × 6mm	8.65mm × 3.9mm
	BQA (WQFN, 14)	3mm × 2.5mm	3mm × 2.5mm
	PW (TSSOP, 14)	5mm × 6.4mm	5mm × 4.4mm

(1) For more information, see Section 10.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.
(3) The body size (length × width) is a nominal value and does not include pins.



These five equivalent exclusive-OR symbols are valid for an SN74LVC86A gate in positive logic; negation may be shown at any two ports.

Exclusive-OR Logic

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3 Pin Configuration and Functions

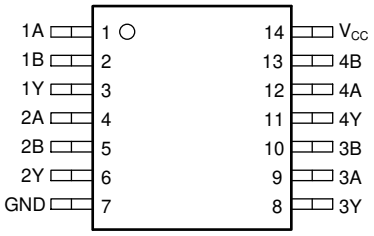


Figure 3-1. SN74LVC86A-Q1 D or PW Package, 14-Pin SOIC or TSSOP (Top View)

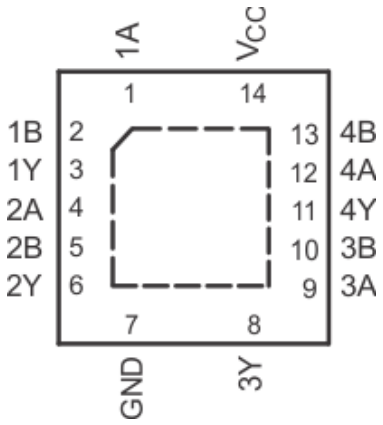


Figure 3-2. SN74LVC86A-Q1 BQA Package, 14-Pin WQFN (Top View)

Table 3-1. Pin Functions

PIN		TYPE[1]	DESCRIPTION
NO.	D, PW, BQA		
	14 PINS		
1A	1	I	Gate 1 input
1B	2	I	Gate 1 input
1Y	3	O	Gate 1 output
2A	4	I	Gate 2 input
2B	5	I	Gate 2 input
2Y	6	O	Gate 2 output
3Y	8	O	Gate 3 output
3A	9	I	Gate 3 input
3B	10	I	Gate 3 input
4Y	11	O	Gate 4 output
4A	12	I	Gate 4 input
4B	13	I	Gate 4 input
GND	7	—	Ground Pin
NC	—	—	Do not connect
V_{CC}	14	—	Power Pin
Thermal pad[2]		—	The thermal pad can be connected to GND or left floating. Do not connect to any other signal or supply.

4 Specifications

4.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	6.5	V
V_I	Input voltage range(2)		–0.5	6.5	V
V_O	Output voltage range(2) (3)		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	V_I < 0		–50	mA
I_{OK}	Output clamp current	V_O < 0		–50	mA
I_O	Continuous output current			±50	mA
	Continuous current through V_{CC} or GND			±100	mA
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The value of V_{CC} is provided in the recommended operating conditions table.

4.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±2000	V

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

4.3 Recommended Operating Conditions

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage	Operating	2	3.6	V
		Data retention only	1.5		
V_{IH}	High-level input voltage	V_{CC} = 2.7 V to 3.6 V	2		V
V_{IL}	Low-level input voltage	V_{CC} = 2.7 V to 3.6 V		0.8	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} = 2.7 V		–12	mA
		V_{CC} = 3 V		–24	
I_{OL}	Low-level output current	V_{CC} = 2.7 V		12	mA
		V_{CC} = 3 V		24	
Δt/Δv	Input transition rise or fall rate			9	ns/V
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*, literature number SCBA004.

4.4 Thermal Information

THERMAL METRIC(1)		SN74LVC86A-Q1			UNIT
		BQA	D	PW	
		14 PINS	14 PINS	14 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	102.3	86	150.8	°C/W

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

4.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		V_{CC}	MIN	TYP(1)	MAX	UNIT
V_{OH}	I_{OH} = –100µA		2.7V to 3.6V	V_{CC} – 0.2			V
	I_{OH} = –12mA		2.7V	2.2			
			3V	2.4			
	I_{OH} = –24mA		3V	2.2			
V_{OL}	I_{OL} = 100µA		2.7V to 3.6V			0.2	V
	I_{OL} = 12mA		2.7V			0.4	
	I_{OL} = 24mA		3V			0.55	
I_I	V_I = 5.5V or GND		3.6V			±5	µA
I_{CC}	V_I = V_{CC} or GND,	I_O = 0	3.6V			10	µA
ΔI_{CC}	One input at V_{CC} –0.6 V,	Other inputs at V_{CC} or GND	2.7V to 3.6V			500	µA
C_i	V_I = V_{CC} or GND		3.3V		5		pF

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

4.6 Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see Load Circuit and Voltage Waveforms)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	
t_{pd}	A	Y		5.6	1	4.6	ns

4.7 Operating Characteristics

T_A = 25°C

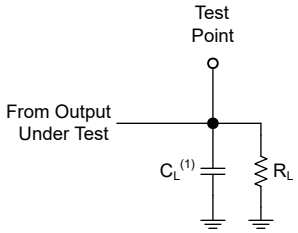
PARAMETER		TEST CONDITIONS	V_{CC} = 2.5 V	V_{CC} = 3.3 V	UNIT
			TYP	TYP	
C_{pd}	Power dissipation capacitance per gate	f = 10 MHz	7.5	8.5	pF

5 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily for the examples listed in the following table. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1MHz, Z_O = 50Ω, t_t ≤ 2.5ns.

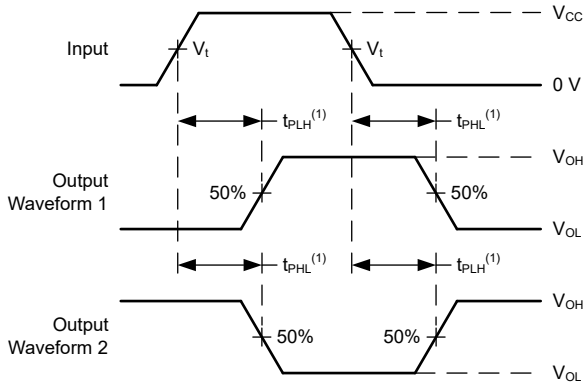
The outputs are measured individually with one input transition per measurement.

V_{CC}	V_t	R_L	C_L	ΔV
1.8V ± 0.15V	V_{CC}/2	1kΩ	30pF	0.15V
2.5V ± 0.2V	V_{CC}/2	500Ω	30pF	0.15V
2.7V	1.5V	500Ω	50pF	0.3V
3.3V ± 0.3V	1.5V	500Ω	50pF	0.3V



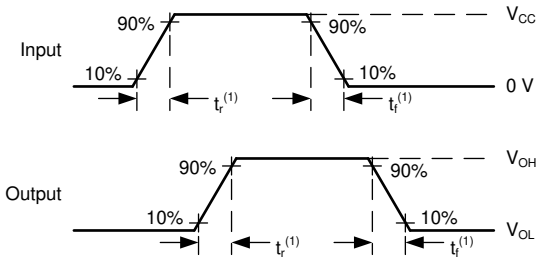
(1) C_L includes probe and test-fixture capacitance.

Figure 5-1. Load Circuit for Push-Pull Outputs



(1) The greater between t_{PLH} and t_{PHL} is the same as t_{pd}.

Figure 5-2. Voltage Waveforms Propagation Delays



(1) The greater between t_r and t_f is the same as t_t.

Figure 5-3. Voltage Waveforms, Input and Output Transition Times

6 Detailed Description

6.1 Overview

The device performs the Boolean function $Y = A \oplus B$ or $Y = \overline{A}B + A\overline{B}$ in positive logic.

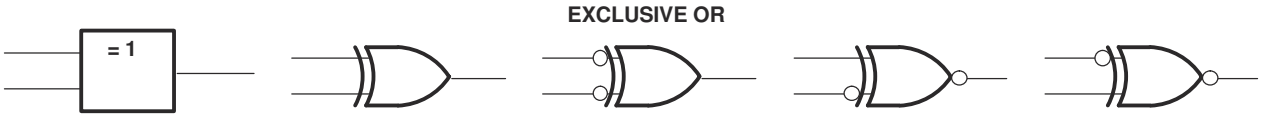
A common application is as a true/complement element. If one of the inputs is low, the other input is reproduced in true form at the output. If one of the inputs is high, the signal on the other input is reproduced inverted at the output.

Inputs can be driven from either 3.3V or 5V devices. This feature allows the use of this device as a translator in a mixed 3.3V/5V system environment.

6.2 Functional Block Diagram

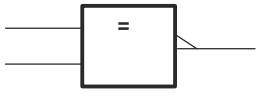
Exclusive-OR Logic

An exclusive-OR gate has many applications, some of which can be represented better by alternative logic symbols.



These five equivalent exclusive-OR symbols are valid for an SN74LVC86A gate in positive logic; negation may be shown at any two ports.

LOGIC-IDENTITY ELEMENT

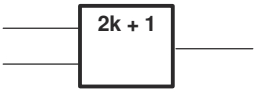


The output is active (low) if all inputs stand at the same logic level (i.e., A = B).

EVEN-PARITY ELEMENT

The output is active (low) if an even number of inputs (i.e., 0 or 2) are active.

ODD-PARITY ELEMENT



The output is active (high) if an odd number of inputs (i.e., only 1 of the 2) are active.

6.3 Device Functional Modes

Function Table (Each Gate)

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

7 Application and Implementation

7.1 Power Supply Recommendations

The power supply can be any voltage between the MIN and MAX supply voltage rating located in the *Section 4.3* table.

Each V_{CC} pin should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, 0.1 µF is recommended; if there are multiple V_{CC} pins, then 0.01 µF or 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.

7.2 Layout

7.2.1 Layout Guidelines

When using multiple bit logic devices inputs should never float.

In many cases, functions or parts of functions of digital logic devices are unused, for example, when only two inputs of a triple-input AND gate are used or 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. Section 7.2.2 specifies the 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 generally acceptable to float outputs, unless the part is a transceiver.

7.2.2 Layout Example

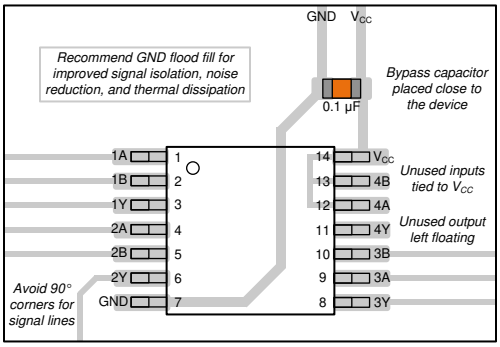


Figure 7-1. Example Layout for the SN74LVC86A-Q1

8 Device and Documentation Support

8.1 Documentation Support (Analog)

8.1.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 8-1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
SN74LVC86A-Q1	Click here	Click here	Click here	Click here	Click here

8.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* 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.

8.3 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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8.4 Trademarks

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8.5 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.

8.6 Glossary

TI Glossary — This glossary lists and explains terms, acronyms, and definitions.

9 Revision History

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

Changes from Revision C (May 2024) to Revision D (August 2024) — **Page**

- Updated RθJA values: PW = 113 to 150.8, all values in °C/W 4

Changes from Revision B (February 2008) to Revision C (May 2024) — **Page**

- Added BQA package to *Package Information* table, *Pin Configuration and Functions* section, and *Thermal Information* table 1
- Added *Package Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Device Functional Modes,*Application and Implementation section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section 1
- Deleted references to machine model throughout the data sheet 1

10 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
SN74LVC86AQDRG4Q1	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVC86AQ	Samples
SN74LVC86AQPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVC86AQ	Samples
SN74LVC86AQPWRQ1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVC86AQ	Samples
SN74LVC86AWBQARQ1	ACTIVE	WQFN	BQA	14	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVC86Q	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.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF SN74LVC86A-Q1 :

- Catalog : SN74LVC86A
- Enhanced Product : SN74LVC86A-EP
- Military : SN54LVC86A

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

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