

# SN5486, SN54LS86A, SN54S86 SN7486, SN74LS86A, SN74S86 QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

SDLS124 - DECEMBER 1972 - REVISED MARCH 1988

- Package Options Include Plastic "Small Outline" Packages, Ceramic Chip Carriers and Flat Packages, and Standard Plastic and Ceramic 300-mil DIPs
- Dependable Texas Instruments Quality and Reliability

| TYPE   | TYPICAL AVERAGE PROPAGATION DELAY TIME | TYPICAL TOTAL POWER DISSIPATION |
|--------|--|---------------------------------|
| '86    | 14 ns                                  | 150 mW                          |
| 'LS86A | 10 ns                                  | 30.5 mW                         |
| 'S86   | 7 ns                                   | 250 mW                          |

## description

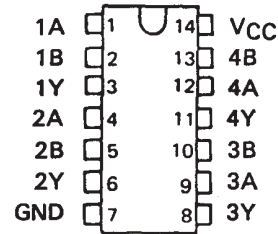
These devices contain four independent 2-input Exclusive-OR gates. They perform the Boolean functions  $Y = A \oplus B = \bar{A}B + A\bar{B}$  in positive logic.

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

The SN5486, 54LS86A, and the SN54S86 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN7486, SN74LS86A, and the SN74S86 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

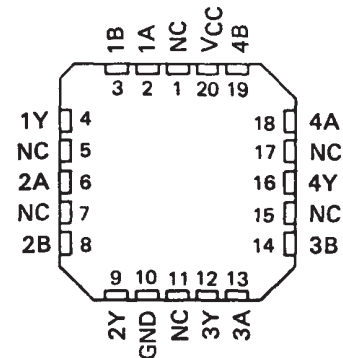
SN5486, SN54LS86A, SN54S86 . . . J OR W PACKAGE  
SN7486 . . . N PACKAGE  
SN74LS86A, SN74S86 . . . D OR N PACKAGE

(TOP VIEW)



SN54LS86A, SN54S86 . . . FK PACKAGE

(TOP VIEW)



NC - No internal connection

## exclusive-OR logic

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



These are five equivalent Exclusive-OR symbols valid for an '86 or 'LS86A gate in positive logic; negation may be shown at any two ports.

**LOGIC IDENTITY ELEMENT**



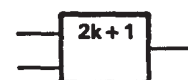
The output is active (low) if all inputs stand at the same logic level (i.e.,  $A=B$ ).

**EVEN-PARITY**



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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

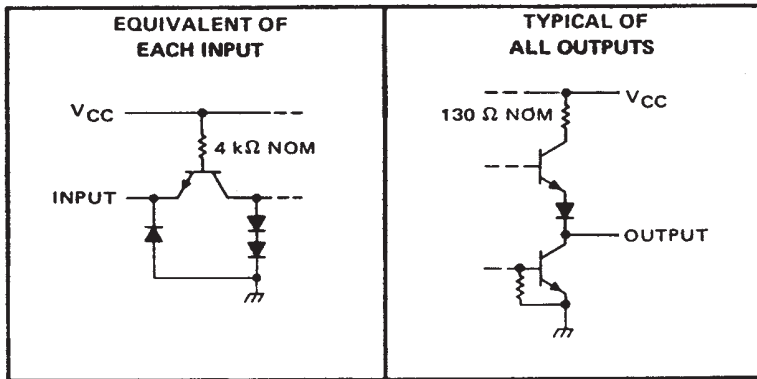
Copyright © 1988, Texas Instruments Incorporated

SN5486, SN54LS86A, SN54S86  
 SN7486, SN74LS86A, SN74S86  
 QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

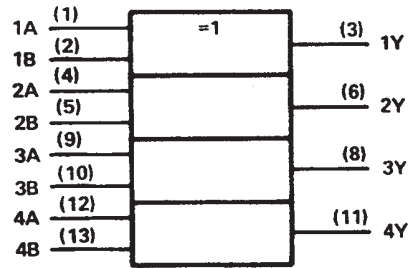
SDLS124 - DECEMBER 1972 - REVISED MARCH 1988

schematics of inputs and outputs

'86

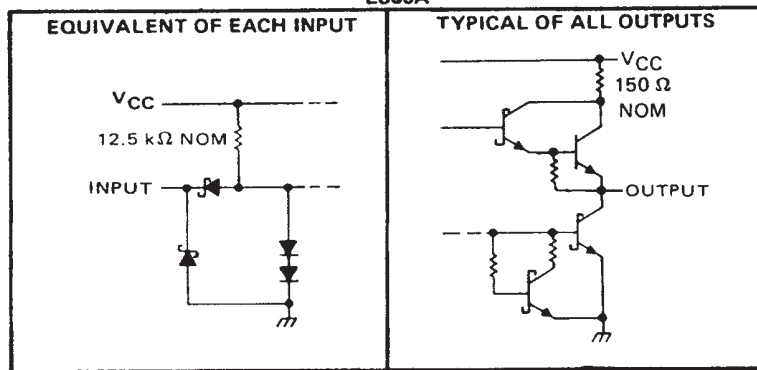


logic symbol†



†This symbol is in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12. Pin numbers shown are for D, J, N, and W packages.

'LS86A

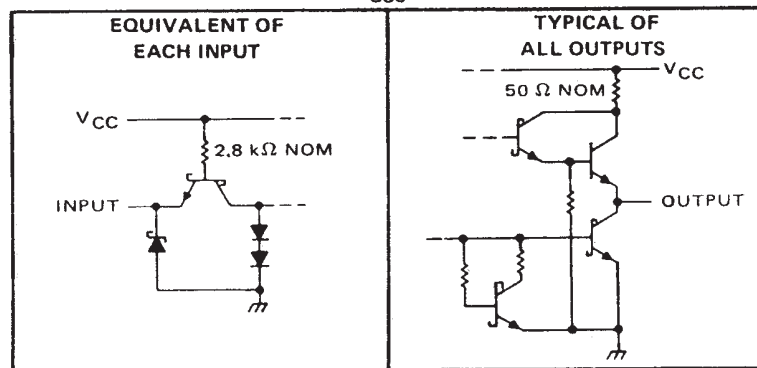


FUNCTION TABLE

| INPUTS |   | OUTPUT |
|--------|---|--------|
| A      | B | Y      |
| L      | L | L      |
| L      | H | H      |
| H      | L | H      |
| H      | H | L      |

H = high level, L = low level

'S86



SN5486, SN54LS86A, SN54S86  
SN7486, SN74LS86A, SN74S86  
**QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES**  
SDLS124 – DECEMBER 1972 – REVISED MARCH 1988

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

|  |     |           |
|--|-----|-----------|
| Supply voltage, $V_{CC}$ (see Note 1)        | 7   | V         |
| Input voltage                                | 5.5 | V         |
| Operating free-air temperature range: SN5486 | -55 | °C to 125 |
| SN7486                                       | 0   | °C to 70  |
| Storage temperature range                    | -65 | °C to 150 |

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

|                                       | SN5486 |     |      | SN7486 |     |      | UNIT    |
|---------------------------------------|--------|-----|------|--------|-----|------|---------|
|                                       | MIN    | NOM | MAX  | MIN    | NOM | MAX  |         |
| Supply voltage, $V_{CC}$              | 4.5    | 5   | 5.5  | 4.75   | 5   | 5.25 | V       |
| High-level output current, $I_{OH}$   |        |     | -800 |        |     | -800 | $\mu$ A |
| Low-level output current, $I_{OL}$    |        |     | 16   |        |     | 16   | mA      |
| Operating free-air temperature, $T_A$ | -55    |     | 125  | 0      |     | 70   | °C      |

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

| PARAMETER                                    | TEST CONDITIONS†   | SN5486 |      |      | SN7486 |      |      | UNIT    |    |
|--|--|--------|------|------|--------|------|------|---------|----|
|  |  | MIN    | TYP‡ | MAX  | MIN    | TYP‡ | MAX  |         |    |
| $V_{IH}$ High-level input voltage            |  | 2      |      |      | 2      |      |      | V       |    |
| $V_{IL}$ Low-level input voltage             |  |        |      | 0.8  |        |      | 0.8  | V       |    |
| $V_{IK}$ Input clamp voltage                 | $V_{CC} = \text{MIN}, I_I = -8 \text{ mA}$   |        |      | -1.5 |        |      | -1.5 | V       |    |
| $V_{OH}$ High-level output voltage           | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -800 \mu\text{A}$ | 2.4    | 3.4  |      | 2.4    | 3.4  |      | V       |    |
| $V_{OL}$ Low-level output voltage            | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 16 \text{ mA}$    |        | 0.2  | 0.4  |        | 0.2  | 0.4  | V       |    |
| $I_I$ Input current at maximum input voltage | $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$   |        |      | 1    |        |      | 1    | mA      |    |
| $I_{IH}$ High-level input current            | $V_{CC} = \text{MAX}, V_I = 2.4 \text{ V}$   |        |      | 40   |        |      | 40   | $\mu$ A |    |
| $I_{IL}$ Low-level input current             | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$   |        |      | -1.6 |        |      | -1.6 | mA      |    |
| $I_{OS}$ Short-circuit output current§       | $V_{CC} = \text{MAX}$  |        |      | -20  |        | -55  | -18  | -55     | mA |
| $I_{CC}$ Supply current                      | $V_{CC} = \text{MAX}, \text{ See Note 2}$  |        |      | 30   |        | 43   | 30   | 50      | mA |

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

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

§ Not more than one output should be shorted at a time.

NOTE 2:  $I_{CC}$  is measured with the inputs grounded and the outputs open.

switching characteristics,  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$

| PARAMETER¶ | FROM (INPUT) | TEST CONDITIONS  |  | MIN | TYP | MAX | UNIT |
|------------|--------------|------------------|--|-----|-----|-----|------|
|            |              | Other input low  | Other input high                                       |     |     |     |      |
| $t_{PLH}$  | A or B       | Other input low  | $C_L = 15 \text{ pF}, R_L = 400 \Omega,$<br>See Note 3 |     | 15  | 23  | ns   |
| $t_{PHL}$  |              |                  |  |     | 11  | 17  |      |
| $t_{PLH}$  | A or B       | Other input high | See Note 3   |     | 18  | 30  | ns   |
| $t_{PHL}$  |              |                  |  |     | 13  | 22  |      |

¶  $t_{PLH}$  = propagation delay time, low-to-high-level output

$t_{PHL}$  = propagation delay time, high-to-low-level output

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.



# SN5486, SN54LS86A, SN54S86 SN7486, SN74LS86A, SN74S86 QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

SDLS124 – DECEMBER 1972 – REVISED MARCH 1988

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

|   |                |
|---|----------------|
| Supply voltage, $V_{CC}$ (see Note 1)           | 7 V            |
| Input voltage                                   | 7 V            |
| Operating free-air temperature range: SN54LS86A | -55°C to 125°C |
| SN74LS86A                                       | 0°C to 70°C    |
| Storage temperature range                       | -65°C to 150°C |

NOTE 1: Voltage values are with respect to network ground terminal.

## recommended operating conditions

|                                       | SN54LS86A |     |      | SN74LS86A |     |      | UNIT    |
|---------------------------------------|-----------|-----|------|-----------|-----|------|---------|
|                                       | MIN       | NOM | MAX  | MIN       | NOM | MAX  |         |
| Supply voltage, $V_{CC}$              | 4.5       | 5   | 5.5  | 4.75      | 5   | 5.25 | V       |
| High-level output current, $I_{OH}$   |           |     | -400 |           |     | -400 | $\mu$ A |
| Low-level output current, $I_{OL}$    |           |     | 4    |           |     | 8    | mA      |
| Operating free-air temperature, $T_A$ | -55       |     | 125  | 0         |     | 70   | °C      |

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

| PARAMETER                                    | TEST CONDITIONS†  | SN54LS86A |      |      | SN74LS86A |      |      | UNIT    |
|--|---|-----------|------|------|-----------|------|------|---------|
|  |   | MIN       | TYP‡ | MAX  | MIN       | TYP‡ | MAX  |         |
| $V_{IH}$ High-level input voltage            |   | 2         |      |      | 2         |      |      | V       |
| $V_{IL}$ Low-level input voltage             |   |           |      | 0.7  |           |      | 0.8  | V       |
| $V_{IK}$ Input clamp voltage                 | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$   |           |      | -1.5 |           |      | -1.5 | V       |
| $V_{OH}$ High-level output voltage           | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OH} = -400 \mu\text{A}$ | 2.5       | 3.4  |      | 2.7       | 3.4  |      | V       |
| $V_{OL}$ Low-level output voltage            | $V_{CC} = \text{MIN}, I_{OL} = 4 \text{ mA}$  |           | 0.25 | 0.4  |           | 0.25 | 0.4  | V       |
|  | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OL} = 8 \text{ mA}$     |           |      |      |           | 0.35 | 0.5  |         |
| $I_I$ Input current at maximum input voltage | $V_{CC} = \text{MAX}, V_I = 7 \text{ V}$  |           |      | 0.2  |           |      | 0.2  | mA      |
| $I_{IH}$ High-level input current            | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$  |           |      | 40   |           |      | 40   | $\mu$ A |
| $I_{IL}$ Low-level input current             | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$  |           |      | -0.8 |           |      | -0.8 | mA      |
| $I_{OS}$ Short-circuit output current§       | $V_{CC} = \text{MAX}$   | -20       |      | -100 | -20       |      | -100 | mA      |
| $I_{CC}$ Supply current                      | $V_{CC} = \text{MAX}, \text{ See Note 2}$   |           | 6.1  | 10   |           | 6.1  | 10   | mA      |

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

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

§ Not more than one output should be shorted at a time.

NOTE 2:  $I_{CC}$  is measured with the inputs grounded and the outputs open.

## switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$

| PARAMETER¶ | FROM (INPUT) | TEST CONDITIONS  |  | MIN | TYP | MAX | UNIT |
|------------|--------------|------------------|--|-----|-----|-----|------|
|            |              |                  |  |     |     |     |      |
| $t_{PLH}$  | A or B       | Other input low  | $C_L = 15 \text{ pF}, R_L = 2 \text{ k}\Omega, \text{ See Note 3}$ |     | 12  | 23  | ns   |
| $t_{PHL}$  |              |                  |  |     | 10  | 17  |      |
| $t_{PLH}$  | A or B       | Other input high |  |     | 20  | 30  | ns   |
| $t_{PHL}$  |              |                  |  |     | 13  | 22  |      |

¶  $t_{PLH}$  = propagation delay time, low-to-high-level output

$t_{PHL}$  = propagation delay time, high-to-low-level output

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.



SN5486, SN54LS86A, SN54S86  
SN7486, SN74LS86A, SN74S86  
**QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES**  
SDLS124 – DECEMBER 1972 – REVISED MARCH 1988

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

|   |                |  |
|---|----------------|--|
| Supply voltage, $V_{CC}$ (see Note 1)         | 7 V            |  |
| Input voltage                                 | 5.5 V          |  |
| Operating free-air temperature range: SN54S86 | –55°C to 125°C |  |
| SN74S86                                       | 0°C to 70°C    |  |
| Storage temperature range                     | –65°C to 150°C |  |

NOTE 1: Voltage values are with respect to network ground terminal.

**recommended operating conditions**

|                                       | SN54S86 |     |     | SN74S86 |     |      | UNIT |
|---------------------------------------|---------|-----|-----|---------|-----|------|------|
|                                       | MIN     | NOM | MAX | MIN     | NOM | MAX  |      |
| Supply voltage, $V_{CC}$              | 4.5     | 5   | 5.5 | 4.75    | 5   | 5.25 | V    |
| High-level output current, $I_{OH}$   |         |     | –1  |         |     | –1   | mA   |
| Low-level output current, $I_{OL}$    |         |     | 20  |         |     | 20   | mA   |
| Operating free-air temperature, $T_A$ | –55     |     | 125 | 0       |     | 70   | °C   |

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

| PARAMETER                                    | TEST CONDITIONS†  | SN54S86 |      |      | SN74S86 |      |      | UNIT |
|--|---|---------|------|------|---------|------|------|------|
|  |   | MIN     | TYP‡ | MAX  | MIN     | TYP‡ | MAX  |      |
| $V_{IH}$ High-level input voltage            |   | 2       |      |      | 2       |      |      | V    |
| $V_{IL}$ Low-level input voltage             |   |         |      | 0.8  |         |      | 0.8  | V    |
| $V_{IK}$ Input clamp voltage                 | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$   |         |      | –1.2 |         |      | –1.2 | V    |
| $V_{OH}$ High-level output voltage           | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -1 \text{ mA}$ | 2.5     | 3.4  |      | 2.7     | 3.4  |      | V    |
| $V_{OL}$ Low-level output voltage            | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 20 \text{ mA}$ |         |      | 0.5  |         |      | 0.5  | V    |
| $I_I$ Input current at maximum input voltage | $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$  |         |      | 1    |         |      | 1    | mA   |
| $I_{IH}$ High-level input current            | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$  |         |      | 50   |         |      | 50   | µA   |
| $I_{IL}$ Low-level input current             | $V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$  |         |      | –2   |         |      | –2   | mA   |
| $I_{OS}$ Short-circuit output current §      | $V_{CC} = \text{MAX}$   | –40     |      | –100 | –40     |      | –100 | mA   |
| $I_{CC}$ Supply current                      | $V_{CC} = \text{MAX}, \text{ See Note 2}$   |         | 50   | 75   |         | 50   | 75   | mA   |

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

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

§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

NOTE 2:  $I_{CC}$  is measured with the inputs grounded and the outputs open.

**switching characteristics,  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$**

| PARAMETER¶ | FROM (INPUT) | TEST CONDITIONS  |   | MIN | TYP | MAX  | UNIT |
|------------|--------------|------------------|---|-----|-----|------|------|
|            |              |                  |   |     |     |      |      |
| $t_{PLH}$  | A or B       | Other input low  | $C_L = 15 \text{ pF}, R_L = 280 \Omega, \text{ See Note 3}$ |     | 7   | 10.5 | ns   |
| $t_{PHL}$  |              |                  |   |     | 6.5 | 10   |      |
| $t_{PLH}$  | A or B       | Other input high |   |     | 7   | 10.5 | ns   |
| $t_{PHL}$  |              |                  |   |     | 6.5 | 10   |      |

¶  $t_{PLH}$  = propagation delay time, low-to-high-level output

¶  $t_{PHL}$  = propagation delay time, high-to-low-level output

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.



## IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.