

# SN54F86, SN74F86 QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

SDFS019B – JANUARY 1989 – REVISED JANUARY 1997

- Package Options Include Plastic Small-Outline (D) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) 300-mil DIPs

## description

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

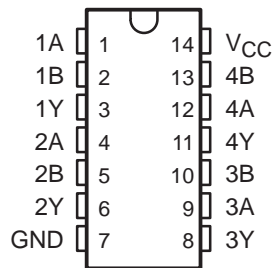
A common application is as a true/complement element. If one of the inputs is low, the other input is reproduced in true form at the output. If one of the inputs is high, the signal on the other input is reproduced inverted at the output.

The SN54F86 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74F86 is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

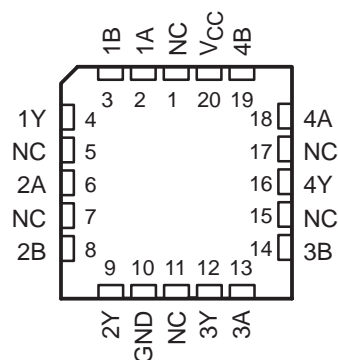
FUNCTION TABLE  
(each gate)

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

SN54F86 . . . J PACKAGE  
SN74F86 . . . D OR N PACKAGE  
(TOP VIEW)

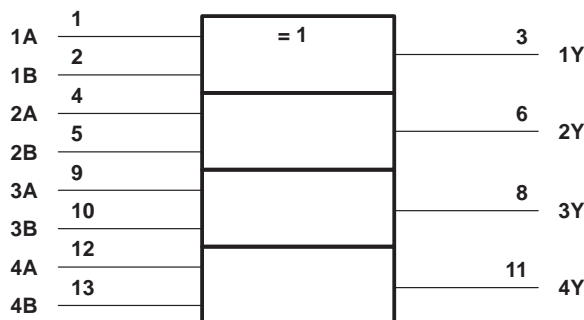


SN54F86 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

## logic symbol†



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



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**TEXAS  
INSTRUMENTS**

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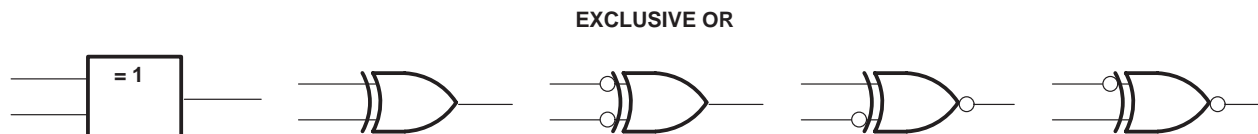
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## exclusive-OR logic

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 'F86 gate in positive logic; negation may be shown at any two ports.

### LOGIC-IDENTITY ELEMENT



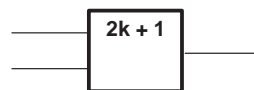
The output is active (low) if all inputs stand at the same logic level (i.e.,  $A = B$ ).

### 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 outputs (i.e., only 1 of the 2) are active.

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

|  |                    |
|--|--------------------|
| Supply voltage range, $V_{CC}$ .....                                   | -0.5 V to 7 V      |
| Input voltage range, $V_I$ (see Note 1) .....                          | -1.2 V to 7 V      |
| Input current range .....  | -30 mA to 5 mA     |
| Voltage range applied to any output in the high state .....            | -0.5 V to $V_{CC}$ |
| Current into any output in the low state .....                         | 40 mA              |
| Package thermal impedance, $\theta_{JA}$ (see Note 2): D package ..... | 127°C/W            |
| N package .....  | 78°C/W             |
| Storage temperature range, $T_{stg}$ .....                             | -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.

- NOTES: 1. The input voltage ratings may be exceeded provided the input current ratings are observed.  
2. The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51, except for through-hole packages, which use a trace length of zero.

## recommended operating conditions

|          |                                | SN54F86 |     |     | SN74F86 |     |     | UNIT |
|----------|--------------------------------|---------|-----|-----|---------|-----|-----|------|
|          |                                | MIN     | NOM | MAX | MIN     | NOM | MAX |      |
| $V_{CC}$ | Supply voltage                 | 4.5     | 5   | 5.5 | 4.5     | 5   | 5.5 | V    |
| $V_{IH}$ | High-level input voltage       | 2       |     |     | 2       |     |     | V    |
| $V_{IL}$ | Low-level input voltage        |         |     | 0.8 |         |     | 0.8 | V    |
| $I_{IK}$ | Input clamp current            |         |     | -18 |         |     | -18 | mA   |
| $I_{OH}$ | High-level output current      |         |     | -1  |         |     | -1  | mA   |
| $I_{OL}$ | Low-level output current       |         |     | 20  |         |     | 20  | mA   |
| $T_A$    | Operating free-air temperature | -55     |     | 125 | 0       |     | 70  | °C   |

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

| PARAMETER         | TEST CONDITIONS                                       | SN54F86 |      |      | SN74F86 |      |      | UNIT          |
|-------------------|---|---------|------|------|---------|------|------|---------------|
|                   |   | MIN     | TYP† | MAX  | MIN     | TYP† | MAX  |               |
| $V_{IK}$          | $V_{CC} = 4.5\text{ V}$ ,<br>$I_I = -18\text{ mA}$    | -1.2    |      |      | -1.2    |      |      | V             |
| $V_{OH}$          | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OH} = -1\text{ mA}$  | 2.5     | 3.4  |      | 2.5     | 3.4  |      | V             |
|                   | $V_{CC} = 4.75\text{ V}$ ,<br>$I_{OH} = -1\text{ mA}$ | 2.7     |      |      |         |      |      |               |
| $V_{OL}$          | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OL} = 20\text{ mA}$  | 0.3 0.5 |      |      | 0.3 0.5 |      |      | V             |
| $I_I$             | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 7\text{ V}$       | 0.1     |      |      | 0.1     |      |      | mA            |
| $I_{IH}$          | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 2.7\text{ V}$     | 20      |      |      | 20      |      |      | $\mu\text{A}$ |
| $I_{IL}$          | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 0.5\text{ V}$     | -0.6    |      |      | -0.6    |      |      | mA            |
| $I_{OS}^\ddagger$ | $V_{CC} = 5.5\text{ V}$ ,<br>$V_O = 0$                | -60     |      | -150 | -60     |      | -150 | mA            |
| $I_{CCH}$         | $V_{CC} = 5.5\text{ V}$ ,<br>See Note 3               | 15      | 23   |      | 15      | 23   |      | mA            |
| $I_{CCL}$         | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 4.5\text{ V}$     | 18      | 28   |      | 18      | 28   |      | mA            |

† 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 the duration of the short circuit should not exceed one second.

NOTE 3:  $I_{CCH}$  is measured with outputs open, and the A or B input (not both) at 4.5 V. Remaining inputs are grounded.

## switching characteristics (see Figure 1)

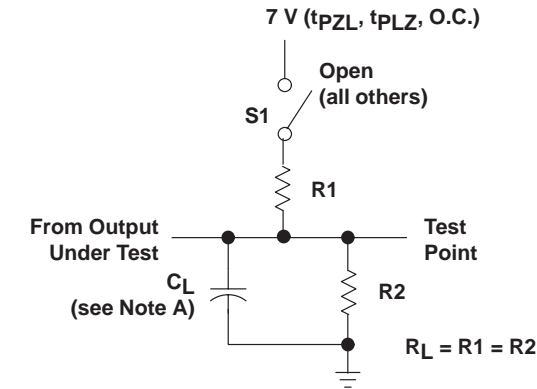
| PARAMETER | FROM (INPUT)                 | TO (OUTPUT) | $V_{CC} = 5\text{ V}$ ,<br>$C_L = 50\text{ pF}$ ,<br>$R_L = 500\ \Omega$ ,<br>$T_A = 25^\circ\text{C}$ |     |     | $V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ ,<br>$C_L = 50\text{ pF}$ ,<br>$R_L = 500\ \Omega$ ,<br>$T_A = \text{MIN to MAX}^\S$ |     |         |     | UNIT |
|-----------|------------------------------|-------------|--|-----|-----|---|-----|---------|-----|------|
|           |                              |             | 'F86   |     |     | SN54F86   |     | SN74F86 |     |      |
|           |                              |             | MIN  | TYP | MAX | MIN   | MAX | MIN     | MAX |      |
| $t_{PLH}$ | A or B<br>(other input low)  | Y           | 3  | 4   | 5.5 | 3   | 7   | 3       | 6.5 | ns   |
| $t_{PHL}$ |                              |             | 3  | 4.2 | 5.5 | 2.6   | 8   | 3       | 6.5 |      |
| $t_{PLH}$ | A or B<br>(other input high) | Y           | 3.5  | 5.3 | 7   | 3.5   | 10  | 3.5     | 8   | ns   |
| $t_{PHL}$ |                              |             | 3  | 4.7 | 6.5 | 3   | 8   | 3       | 7.5 |      |

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

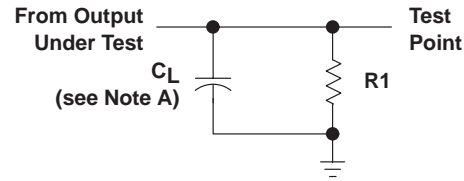
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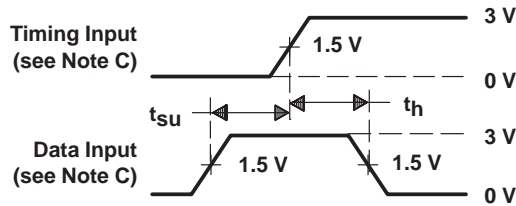
## PARAMETER MEASUREMENT INFORMATION



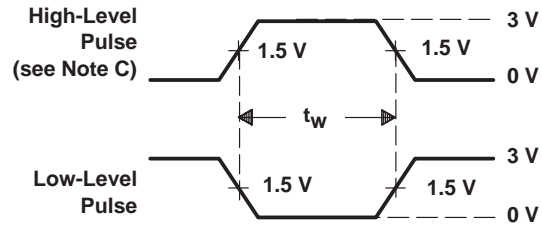
LOAD CIRCUIT FOR 3-STATE AND OPEN-COLLECTOR OUTPUTS



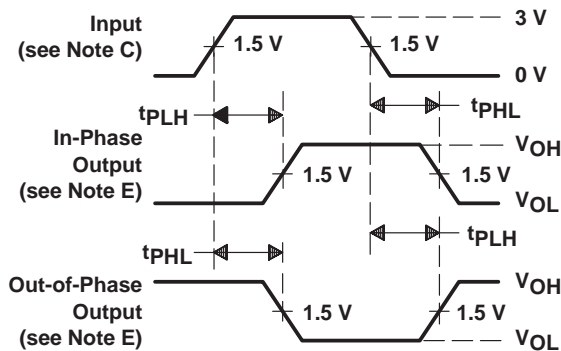
LOAD CIRCUIT FOR TOTEM-POLE OUTPUTS



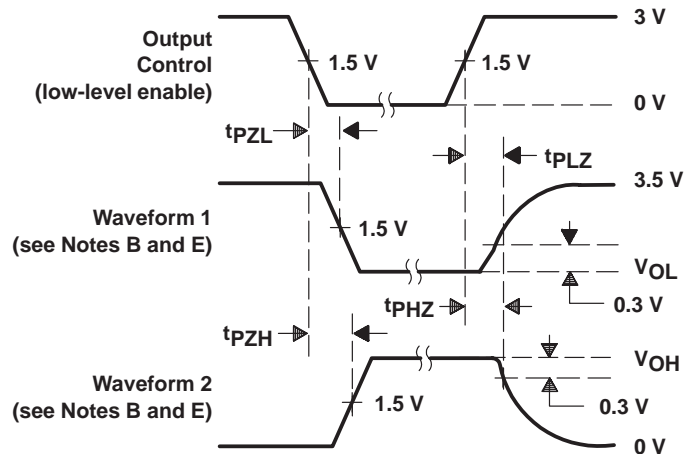
VOLTAGE WAVEFORMS SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS PULSE DURATION



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES (see Note D)



VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

- 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:  $PRR \leq 1$  MHz,  $t_r = t_f \leq 2.5$  ns, duty cycle = 50%.  
D. When measuring propagation delay times of 3-state outputs, switch S1 is open.  
E. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

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