

SDLS034

# QUADRUPLE 2-INPUT POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS

SN5409, SN54LS09, SN54S09,  
SN7409, SN74LS09, SN74S09  
DECEMBER 1983—REVISED MARCH 1988

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

SN5409, SN54LS09, SN54S09 . . . J OR W PACKAGE  
SN7409 . . . N PACKAGE  
SN74LS09, SN74S09 . . . D OR N PACKAGE  
(TOP VIEW)

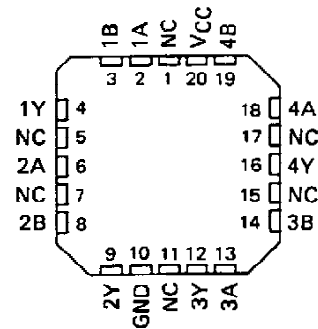


**description**

These devices contain four independent 2-input AND gates. The open-collector outputs require pull-up resistors to perform correctly. They may be connected to other open-collector outputs to implement active-low wired-OR or active-high wired-AND functions. Open-collector devices are often used to generate higher  $V_{OH}$  levels.

The SN5409, SN54LS09, and SN54S09 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN7409, SN74LS09, and SN74S09 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

SN54LS09, SN54S09 . . . FK PACKAGE  
(TOP VIEW)



NC—No internal connection

**FUNCTION TABLE (each gate)**

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

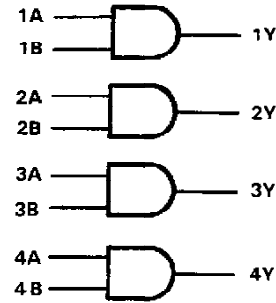
**logic symbol**



† 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.

**logic diagram (positive logic)**



$$Y = A \cdot B \text{ or } Y = \overline{\overline{A} + \overline{B}}$$

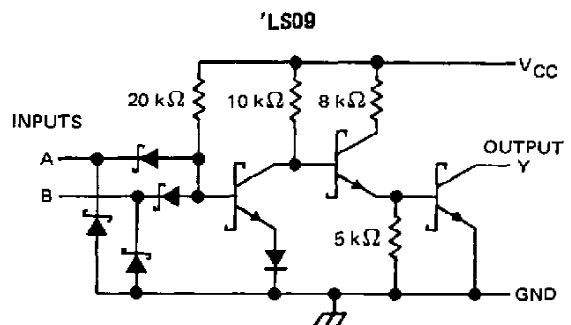
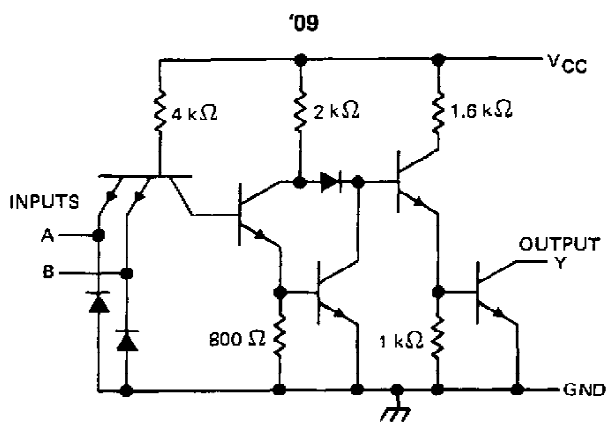
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**SN5409, SN54LS09, SN54S09,  
SN7409, SN74LS09, SN74S09  
QUADRUPLE 2-INPUT POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS**

schematics (each gate)



Resistor values shown are nominal.

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

|   |                |
|---|----------------|
| Supply voltage, $V_{CC}$ (see Note 1) .....       | 7 V            |
| Input voltage: '09, 'S09 .....                    | 5.5 V          |
| 'LS09 .....                                       | 7 V            |
| Off-state output voltage .....                    | 7 V            |
| Operating free-air temperature range: SN54' ..... | -55°C to 125°C |
| SN74' .....                                       | 0°C to 70°C    |
| Storage temperature range .....                   | -65°C to 150°C |

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

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**SN5409, SN7409**  
**QUADRUPLE 2-INPUT POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS**

**recommended operating conditions**

|                                      | SN5409 |     |     | SN7409 |     |      | UNIT |
|--------------------------------------|--------|-----|-----|--------|-----|------|------|
|                                      | MIN    | NOM | MAX | MIN    | NOM | MAX  |      |
| $V_{CC}$ Supply voltage              | 4.5    | 5   | 5.5 | 4.75   | 5   | 5.25 | V    |
| $V_{IH}$ High-level input voltage    | 2      |     |     | 2      |     |      | V    |
| $V_{IL}$ Low-level input voltage     |        |     | 0.8 |        |     | 0.8  | V    |
| $V_{OH}$ High-level output voltage   |        |     | 5.5 |        |     | 5.5  | V    |
| $I_{OL}$ Low-level output current    |        |     | 16  |        |     | 16   | mA   |
| $T_A$ Operating free-air temperature | -55    |     | 125 | 0      |     | 70   | °C   |

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

| PARAMETER | TEST CONDITIONS†  | MIN | TYP‡ | MAX  | UNIT |
|-----------|---|-----|------|------|------|
| $V_{IK}$  | $V_{CC} = \text{MIN}$ , $I_I = -12 \text{ mA}$                              |     |      | -1.5 | V    |
| $I_{OH}$  | $V_{CC} = \text{MIN}$ , $V_{IH} = 2 \text{ V}$ , $V_{OH} = 5.5 \text{ V}$   |     |      | 0.25 | mA   |
| $V_{OL}$  | $V_{CC} = \text{MIN}$ , $V_{IL} = 0.8 \text{ V}$ , $I_{OL} = 16 \text{ mA}$ |     | 0.2  | 0.4  | V    |
| $I_I$     | $V_{CC} = \text{MAX}$ , $V_I = 5.5 \text{ V}$                               |     |      | 1    | mA   |
| $I_{IH}$  | $V_{CC} = \text{MAX}$ , $V_I = 2.4 \text{ V}$                               |     |      | 40   | μA   |
| $I_{IL}$  | $V_{CC} = \text{MAX}$ , $V_I = 0.4 \text{ V}$                               |     |      | -1.6 | mA   |
| $I_{CCH}$ | $V_{CC} = \text{MAX}$ , $V_I = 4.5 \text{ V}$                               |     | 11   | 21   | mA   |
| $I_{CCL}$ | $V_{CC} = \text{MAX}$ , $V_I = 0 \text{ V}$                                 |     | 20   | 33   | mA   |

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

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

**switching characteristics,  $V_{CC} = 5 \text{ V}$ ,  $T_A = 25^\circ\text{C}$  (see note 2)**

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS                            | MIN | TYP | MAX | UNIT |
|-----------|--------------|-------------|--|-----|-----|-----|------|
| $t_{PLH}$ | A or B       | Y           | $R_L = 400 \Omega$ , $C_L = 15 \text{ pF}$ |     | 21  | 32  | ns   |
| $t_{PHL}$ |              |             |  |     | 16  | 24  | ns   |

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.



# SN54LS09, SN74LS09 QUADRUPLE 2-INPUT POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS

## recommended operating conditions

|   | SN54LS09 |     |     | SN74LS09 |     |      | UNIT |
|---|----------|-----|-----|----------|-----|------|------|
|   | MIN      | NOM | MAX | MIN      | NOM | MAX  |      |
| V <sub>CC</sub> Supply voltage                | 4.5      | 5   | 5.5 | 4.75     | 5   | 5.25 | V    |
| V <sub>IH</sub> High-level input voltage      | 2        |     |     | 2        |     |      | V    |
| V <sub>IL</sub> Low-level input voltage       |          |     | 0.7 |          |     | 0.8  | V    |
| V <sub>OH</sub> High-level output voltage     |          |     | 5.5 |          |     | 5.5  | V    |
| I <sub>OL</sub> Low-level output current      |          |     | 4   |          |     | 8    | mA   |
| T <sub>A</sub> Operating free-air temperature | -55      |     | 125 | 0        |     | 70   | °C   |

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

| PARAMETER        | TEST CONDITIONS †   | SN54LS09 |       |      | SN74LS09 |       |      | UNIT |
|------------------|---|----------|-------|------|----------|-------|------|------|
|                  |   | MIN      | TYP ‡ | MAX  | MIN      | TYP ‡ | MAX  |      |
| V <sub>IK</sub>  | V <sub>CC</sub> = MIN, I <sub>I</sub> = -18 mA                        |          |       | -1.5 |          |       | -1.5 | V    |
| I <sub>OH</sub>  | V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>OH</sub> = 5.5 V |          |       | 0.1  |          |       | 0.1  | mA   |
| V <sub>OL</sub>  | V <sub>CC</sub> = MIN, V <sub>IL</sub> = MAX, I <sub>OL</sub> = 4 mA  |          | 0.25  | 0.4  |          | 0.25  | 0.4  | V    |
|                  | V <sub>CC</sub> = MIN, V <sub>IL</sub> = MAX, I <sub>OL</sub> = 8 mA  |          |       |      |          | 0.35  | 0.5  |      |
| I <sub>I</sub>   | V <sub>CC</sub> = MAX, V <sub>I</sub> = 7 V                           |          |       | 0.1  |          |       | 0.1  | mA   |
| I <sub>IH</sub>  | V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.7 V                         |          |       | 20   |          |       | 20   | μA   |
| I <sub>IL</sub>  | V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V                         |          |       | -0.4 |          |       | -0.4 | mA   |
| I <sub>CCH</sub> | V <sub>CC</sub> = MAX, V <sub>I</sub> = 4.5 V                         |          | 2.4   | 4.8  |          | 2.4   | 4.8  | mA   |
| I <sub>CCL</sub> | V <sub>CC</sub> = MAX, V <sub>I</sub> = 0 V                           |          | 4.4   | 8.8  |          | 4.4   | 8.8  | mA   |

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

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

## switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C (see note 2)

| PARAMETER        | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS                               | MIN | TYP | MAX | UNIT |
|------------------|--------------|-------------|---|-----|-----|-----|------|
| t <sub>PLH</sub> | A or B       | Y           | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 15 pF |     | 20  | 35  | ns   |
| t <sub>PHL</sub> |              |             |   |     | 17  | 35  | ns   |

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

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**SN54S09, SN74S09**  
**QUADRUPLE 2-INPUT POSITIVE-AND GATES WITH OPEN-COLLECTOR OUTPUTS**

**recommended operating conditions**

|   | SN54S09 |     |     | SN74S09 |     |      | UNIT |
|---|---------|-----|-----|---------|-----|------|------|
|   | MIN     | NOM | MAX | MIN     | NOM | MAX  |      |
| V <sub>CC</sub> Supply voltage                | 4.5     | 5   | 5.5 | 4.75    | 5   | 5.25 | V    |
| V <sub>IH</sub> High-level input voltage      | 2       |     |     | 2       |     |      | V    |
| V <sub>IL</sub> Low-level input voltage       |         |     | 0.8 |         |     | 0.8  | V    |
| V <sub>OH</sub> High-level output voltage     |         |     | 5.5 |         |     | 5.5  | V    |
| I <sub>OL</sub> Low-level output current      |         |     | 20  |         |     | 20   | mA   |
| T <sub>A</sub> Operating free-air temperature | -55     |     | 125 | 0       |     | 70   | °C   |

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

| PARAMETER        | TEST CONDITIONS†  | MIN | TYP‡ | MAX  | UNIT |    |
|------------------|---|-----|------|------|------|----|
| V <sub>IK</sub>  | V <sub>CC</sub> = MIN, I <sub>I</sub> = -18 mA                          |     |      | -1.2 | V    |    |
| I <sub>OH</sub>  | V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>OH</sub> = 5.5 V   |     |      | 0.25 | mA   |    |
| V <sub>OL</sub>  | V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.8 V, I <sub>OL</sub> = 20 mA |     |      | 0.5  | V    |    |
| I <sub>I</sub>   | V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V                           |     |      | 1    | mA   |    |
| I <sub>IH</sub>  | V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.7 V                           |     |      | 50   | μA   |    |
| I <sub>IL</sub>  | V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.5 V                           |     |      | -2   | mA   |    |
| I <sub>CCH</sub> | V <sub>CC</sub> = MAX, V <sub>I</sub> = 4.5 V                           |     |      | 18   | 32   | mA |
| I <sub>CCL</sub> | V <sub>CC</sub> = MAX, V <sub>I</sub> = 0 V                             |     |      | 32   | 57   | mA |

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

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

**switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C (see note 2)**

| PARAMETER        | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS                                | MIN | TYP | MAX | UNIT |
|------------------|--------------|-------------|--|-----|-----|-----|------|
| t <sub>PLH</sub> | A or B       | Y           | R <sub>L</sub> = 280 Ω, C <sub>L</sub> = 15 pF | 6.5 | 10  | ns  |      |
| t <sub>PHL</sub> |              |             |  | 6.5 | 10  | ns  |      |
| t <sub>PLH</sub> |              |             | R <sub>L</sub> = 280 Ω, C <sub>L</sub> = 50 pF | 9   | ns  |     |      |
| t <sub>PHL</sub> |              |             |  | 9   | ns  |     |      |

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.



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