

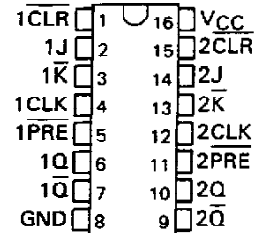
# DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

DECEMBER 1983 — REVISED MARCH 1988

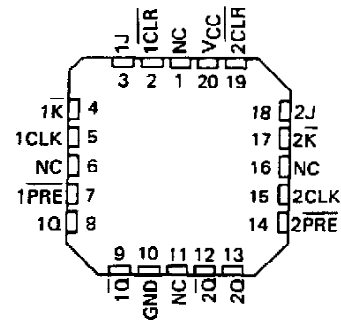
**SN54109, SN54LS109A,  
SN74109, SN74LS109A**

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

SN54109, SN54LS109A . . . J OR W PACKAGE  
SN74109 . . . N PACKAGE  
SN74LS109A . . . D OR N PACKAGE  
(TOP VIEW)



SN54LS109A . . . FK PACKAGE  
(TOP VIEW)



### description

These devices contain two independent J-K positive-edge-triggered flip-flops. A low level at the preset or clear inputs sets or resets the outputs regardless of the levels of the other inputs. When preset and clear are inactive (high), data at the J and K inputs meeting the setup time requirements are transferred to the outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level and is not directly related to the rise time of the clock pulse. Following the hold time interval, data at the J and K inputs may be changed without affecting the levels at the outputs. These versatile flip-flops can perform as toggle flip-flops by grounding K and tying J high. They also can perform as D-type flip-flops if J and K are tied together.

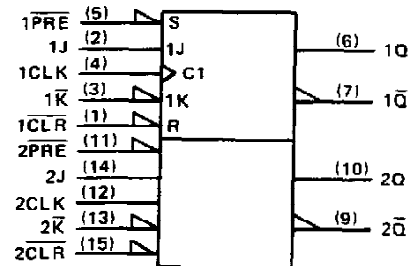
The SN54109 and SN54LS109A are characterized for operation over the full military temperature range of -55°C to 125°C. The SN74109 and SN74LS109A are characterized for operation from 0°C to 70°C.

FUNCTION TABLE (each flip-flop)

| INPUTS |     |     |   |   | OUTPUTS        |                     |
|--------|-----|-----|---|---|----------------|---------------------|
| PRE    | CLR | CLK | J | K | Q              | Q-bar               |
| L      | H   | X   | X | X | H              | L                   |
| H      | L   | X   | X | X | L              | H                   |
| L      | L   | X   | X | X | H <sup>†</sup> | H <sup>†</sup>      |
| H      | H   | ↑   | L | L | L              | H                   |
| H      | H   | ↑   | H | L | TOGGLE         | TOGGLE              |
| H      | H   | ↑   | L | H | Q <sub>0</sub> | Q <sub>0</sub> -bar |
| H      | H   | ↑   | H | H | H              | L                   |
| H      | H   | L   | X | X | Q <sub>0</sub> | Q <sub>0</sub> -bar |

<sup>†</sup> The output levels in this configuration are not guaranteed to meet the minimum levels for V<sub>OH</sub> if the lows at preset and clear are near V<sub>IL</sub> maximum. Furthermore, this configuration is nonstable; that is, it will not persist when preset or clear return to their inactive (high) level.

### logic symbol<sup>‡</sup>



<sup>‡</sup>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.

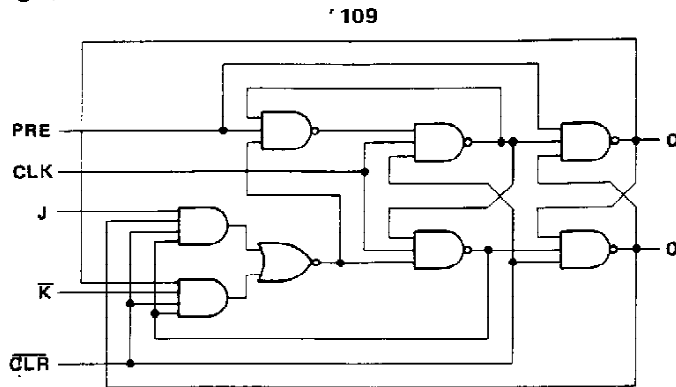
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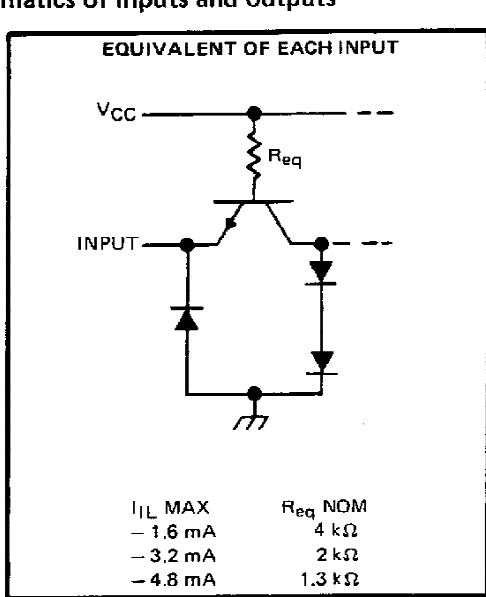
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**SN54109, SN74109**  
**DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR**

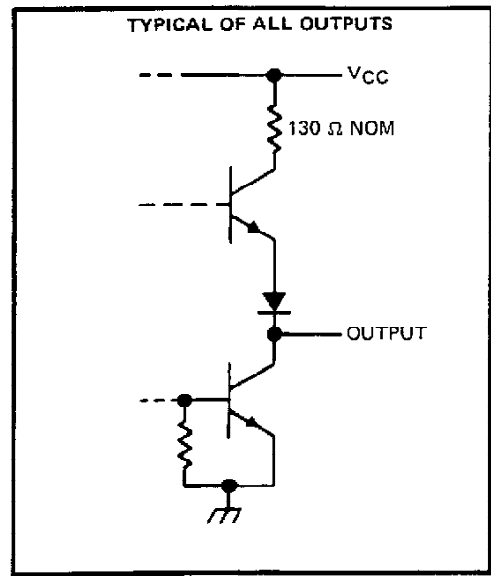
logic diagram (positive logic)



schematics of inputs and outputs



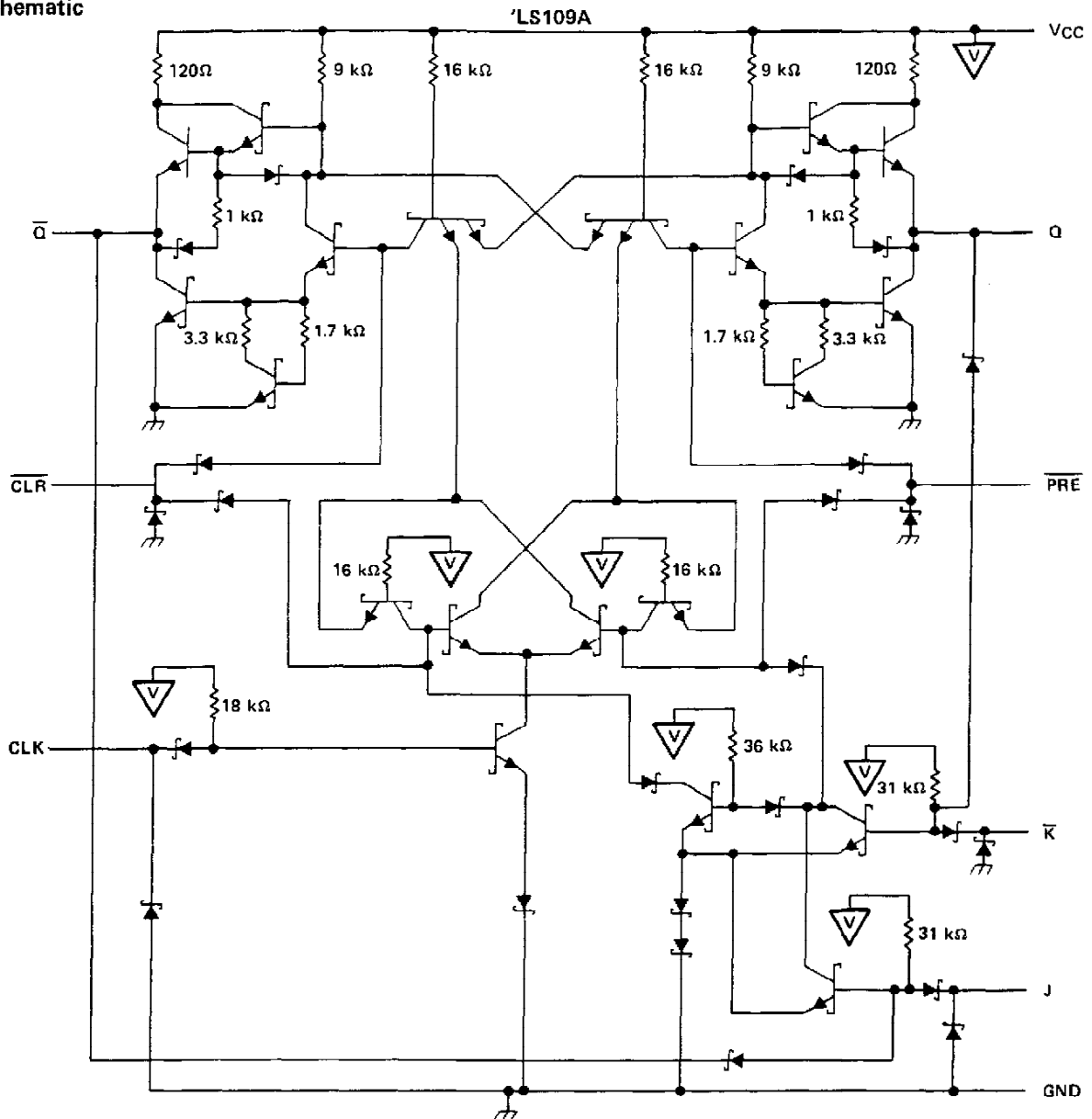
'109



**SN54109, SN54LS109A,  
SN74109, SN74LS109A**

**DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR**

schematic



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

|   |                |
|---|----------------|
| Supply voltage, $V_{CC}$ (see Note 1) .....       | 7 V            |
| Input voltage: '109 .....                         | 5.5 V          |
| 'LS109A .....                                     | 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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# SN54109, SN74109

## DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

### recommended operating conditions

|   | SN54109         |     |      | SN74109 |     |      | 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    |
| I <sub>OH</sub> High-level output current       |                 |     | -0.8 |         |     | -0.8 | mA   |
| I <sub>OL</sub> Low-level output current        |                 |     | 16   |         |     | 16   | mA   |
| t <sub>w</sub> Pulse duration                   | CLK high or low |     | 20   | 20      |     |      | ns   |
|   | PRE or CLR low  |     | 20   | 20      |     |      |      |
| t <sub>su</sub> Input setup time before CLK †   | 10              |     |      | 10      |     |      | ns   |
| t <sub>h</sub> Input hold time-data after CLK † | 6               |     |      | 6       |     |      | ns   |
| 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†   | SN54109                                       |      |      | SN74109 |      |      | UNIT |
|-------------------|--|---|------|------|---------|------|------|------|
|                   |  | MIN   | TYP‡ | MAX  | MIN     | TYP‡ | MAX  |      |
| V <sub>IK</sub>   | V <sub>CC</sub> = MIN, I <sub>I</sub> = -12 mA   |   |      | -1.5 |         |      | -1.5 | V    |
| V <sub>OH</sub>   | V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = -0.8 mA | 2.4   | 3.4  |      | 2.4     | 3.4  |      | V    |
| V <sub>OL</sub>   | V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OL</sub> = 16 mA   |   | 0.2  | 0.4  |         | 0.2  | 0.4  | V    |
| I <sub>I</sub>    | V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V  |   | 1    |      |         | 1    |      | mA   |
| I <sub>IH</sub>   | J or K   |   | 40   |      |         | 40   |      | μA   |
|                   | CLR  |   | 160  |      |         | 160  |      |      |
|                   | PRE or CLK   | V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.4 V |      | 80   |         |      | 80   |      |
| I <sub>IL</sub>   | J or K   |   | -1.6 |      |         | -1.6 |      | mA   |
|                   | CLR †  |   | -4.8 |      |         | -4.8 |      |      |
|                   | PRE †  |   | -3.2 |      |         | -3.2 |      |      |
|                   | CLK  | V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V |      | -3.2 |         |      | -3.2 |      |
| I <sub>OS</sub> § | V <sub>CC</sub> = MAX  | -30   |      | -85  | -30     |      | -85  | mA   |
| I <sub>CC</sub> # | V <sub>CC</sub> = MAX, See Note 2  |   | 9    | 15   |         | 9    | 15   | 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.

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

† Clear is tested with preset high and preset is tested with clear high.

# Average per flip-flop.

NOTE 2: With all outputs open, I<sub>CC</sub> is measured with the Q and Q̄ outputs high in turn. At the time of measurement, the clock input is grounded.

### switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C (see note 3)

| PARAMETER        | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS                                | MIN | TYP | MAX | UNIT |
|------------------|--------------|-------------|--|-----|-----|-----|------|
| f <sub>max</sub> |              |             |  | 25  | 33  |     | MHz  |
| t <sub>PLH</sub> | PRE          | Q           | R <sub>L</sub> = 400 Ω, C <sub>L</sub> = 15 pF |     | 10  | 15  | ns   |
| t <sub>PHL</sub> |              | Q̄          |  |     | 23  | 35  | ns   |
| t <sub>PLH</sub> | CLR          | Q̄          |  |     | 10  | 15  | ns   |
| t <sub>PHL</sub> |              | Q           |  |     | 17  | 25  | ns   |
| t <sub>PLH</sub> | CLK          | Q or Q̄     |  |     | 10  | 16  | ns   |
| t <sub>PHL</sub> |              |             |  |     |     | 18  | 28   |

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



# SN54LS109A, SN74LS109A DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

## recommended operating conditions

|             |                                | SN54LS109A      |     |      | SN74LS109A |     |      | 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        |                 |     | 0.7  |            |     | 0.8  | V    |    |
| $I_{OH}$    | High-level output current      |                 |     | -0.4 |            |     | -0.4 | mA   |    |
| $I_{OL}$    | Low-level output current       |                 |     | 4    |            |     | 8    | mA   |    |
| $f_{clock}$ | Clock frequency                | 0               |     | 25   | 0          |     | 25   | MHz  |    |
| $t_w$       | Pulse duration                 | CLK high        |     | 25   | 25         |     |      | ns   |    |
|             |                                | PRE or CLR low  |     | 25   | 25         |     |      |      |    |
| $t_{su}$    | Setup time before CLK †        | High-level data |     | 35   | 35         |     |      | ns   |    |
|             |                                | Low-level data  |     | 25   | 25         |     |      |      |    |
| $t_h$       | Hold time-data after CLK †     | 5               |     | 5    |            |     |      | ns   |    |
| $T_A$       | Operating free-air temperature | -55             |     | 125  |            | 0   |      | 70   | °C |

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

| PARAMETER        | TEST CONDITIONS†   | SN54LS109A                                 |      | SN74LS109A |      | UNIT          |
|------------------|--|--|------|------------|------|---------------|
|                  |  | MIN  | TYP‡ | MAX        | MIN  |               |
| $V_{IK}$         | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$  | -1.5                                       |      | -1.5       |      | V             |
| $V_{OH}$         | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}, I_{OH} = -0.4 \text{ mA}$ | 2.5  | 3.4  | 2.7        | 3.4  | V             |
| $V_{OL}$         | $V_{CC} = \text{MIN}, I_{OL} = 4 \text{ mA}, V_{IL} = \text{MAX}, V_{IH} = 2 \text{ V}$    | 0.25                                       | 0.4  | 0.25       | 0.4  | V             |
|                  | $V_{CC} = \text{MIN}, I_{OL} = 8 \text{ mA}, V_{IL} = \text{MAX}, V_{IH} = 2 \text{ V}$    |  |      | 0.35       | 0.5  |               |
| $I_I$            | J, K or CLK  | $V_{CC} = \text{MAX}, V_I = 7 \text{ V}$   |      | 0.1        |      | mA            |
|                  | CLR or PRE   | $V_{CC} = \text{MAX}, V_I = 7 \text{ V}$   |      | 0.2        |      |               |
| $I_{IH}$         | J, K or CLK  | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$ |      | 20         |      | $\mu\text{A}$ |
|                  | CLR or PRE   | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$ |      | 40         |      |               |
| $I_{IL}$         | J, K or CLK  | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$ |      | -0.4       |      | mA            |
|                  | CLR or PRE   | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$ |      | -0.8       |      |               |
| $I_{OS}\S$       | $V_{CC} = \text{MAX},$ See Note 4  | -20  | -100 | -20        | -100 | mA            |
| $I_{CC}$ (Total) | $V_{CC} = \text{MAX},$ See Note 2  | 4  |      | 8          |      | mA            |

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

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

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

NOTE 2: With all outputs open,  $I_{CC}$  is measured with the Q and  $\bar{Q}$  outputs high in turn. At the time of measurement, the clock input is grounded.

NOTE 4: For certain devices where state commutation can be caused by shorting an output to ground, an equivalent test may be performed with  $V_O = 2.25 \text{ V}$  and  $2.125 \text{ V}$  for the 54 family and the 74 family, respectively with the minimum and maximum limits reduced to one half of their stated values.

## switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ (see note 3)

| PARAMETER | FROM (INPUT) | TO (OUTPUT)    | TEST CONDITIONS                                | MIN | TYP | MAX | UNIT |
|-----------|--------------|----------------|--|-----|-----|-----|------|
| $f_{max}$ |              |                | $R_L = 2 \text{ k}\Omega, C_L = 15 \text{ pF}$ | 25  | 33  |     | MHz  |
| $t_{PLH}$ | CLR, PRE     | Q or $\bar{Q}$ |  | 13  | 25  |     | ns   |
| $t_{PHL}$ | or CLK       |                |  | 25  | 40  |     | ns   |

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

  
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