

# SN54109, SN54LS109A, SN74109, SN74LS109A DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

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

## 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.

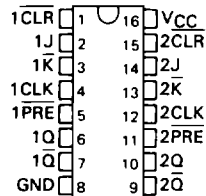
The SN54109 and SN54LS109A are characterized for operation over the full military temperature range of -55°C to 125°C. The SN74109 and SN74LS109A are characterized for operation from 0°C to 70°C.

FUNCTION TABLE (each flip-flop)

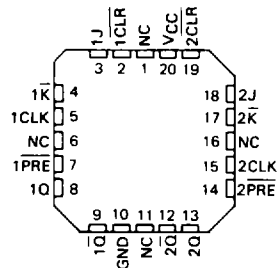
INPUTS					OUTPUTS	
PRE	CLR	CLK	J	K	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H <sup>†</sup>	H <sup>†</sup>
H	H	↑	L	L	L	H
H	H	↑	H	L	TOGGLE	
H	H	↑	L	H	Q <sub>0</sub>	$\bar{Q}_0$
H	H	↑	H	H	H	L
H	H	L	X	X	Q <sub>0</sub>	$\bar{Q}_0$

<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.

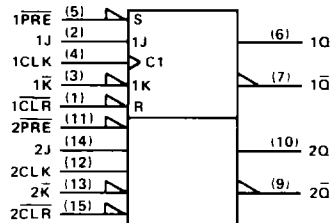
SN54109, SN54LS109A . . . J OR W PACKAGE  
SN74109 . . . N PACKAGE  
SN74LS109A . . . D OR N PACKAGE  
(TOP VIEW)



SN54LS109A . . . FK PACKAGE  
(TOP VIEW)



## 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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PRODUCTION DATA documents contain information 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.

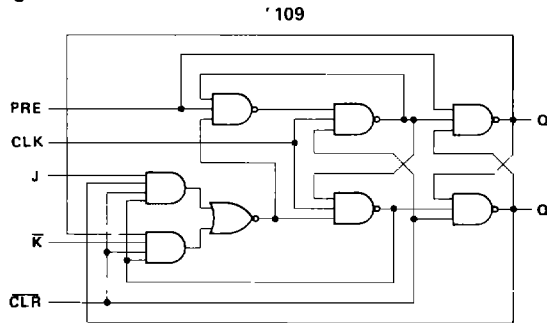
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**SN54109, SN74109**  
**DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR**

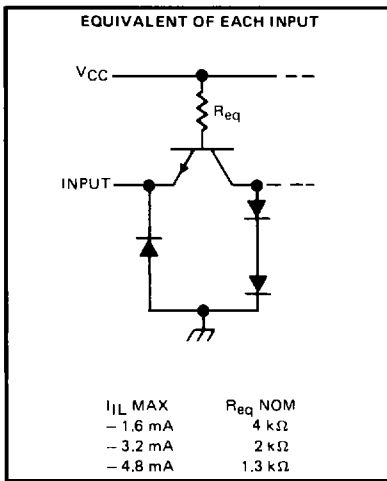
logic diagram (positive logic)



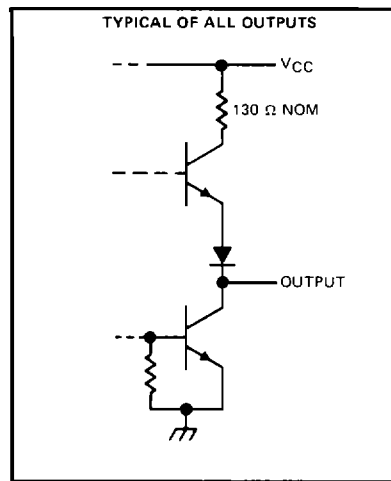
schematics of inputs and outputs

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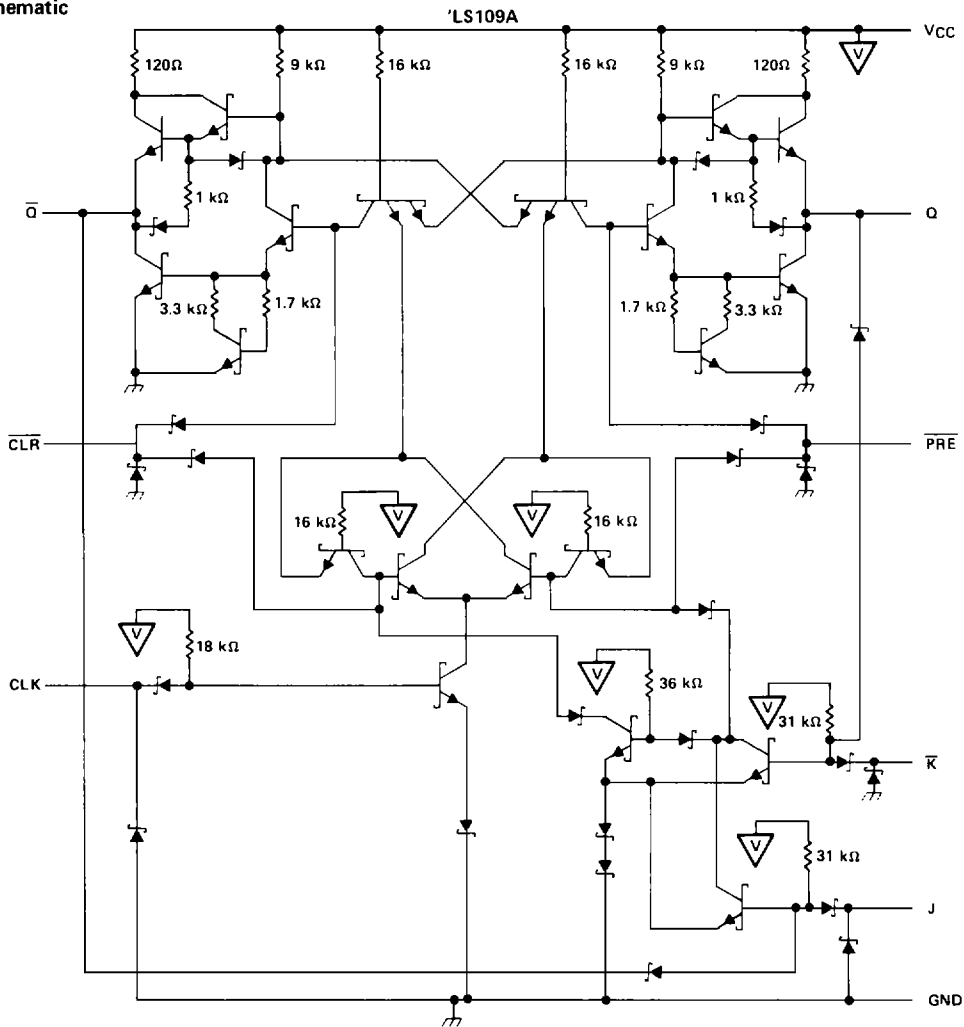
'109



**SN54109, SN54LS109A,  
SN74109, SN74LS109A**

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

schematic



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**absolute maximum ratings over operating free-air temperature (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.

## 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, I <sub>OH</sub> = -0.8 mA, V <sub>IL</sub> = 0.8 V	2.4	3.4		2.4	3.4		V
V <sub>OL</sub>	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 16 mA, V <sub>IL</sub> = 0.8 V		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 †	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V		-3.2			-3.2	
	CLK			-3.2			-3.2	
I <sub>OS</sub> ‡	V <sub>CC</sub> = MAX			-30			-85	mA
I <sub>CC</sub> #	V <sub>CC</sub> = MAX, See Note 2			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  $\bar{Q}$  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>		$\bar{Q}$		23	35		ns
t <sub>PLH</sub>	CLR	$\bar{Q}$		10	15		ns
t <sub>PHL</sub>		Q		17	25		ns
t <sub>PLH</sub>	CLK	Q or $\bar{Q}$		10	16		ns
t <sub>PHL</sub>				18	28		ns

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

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

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

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

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

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

<sup>§</sup> 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	26		ns
$t_{PHL}$	or CLK				25	40		ns

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

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