

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.

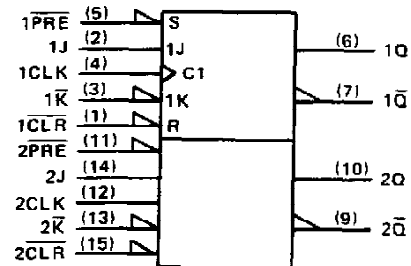
The SN54109 and SN54LS109A are characterized for operation over the full military temperature range of -55°C to 125°C. The SN74109 and SN74LS109A are characterized for operation from 0°C to 70°C.

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†	H†
H	H	↑	L	L	L	H
H	H	↑	H	L	TOGGLE	TOGGLE
H	H	↑	L	H	Q ₀	Q ₀ -bar
H	H	↑	H	H	H	L
H	H	L	X	X	Q ₀	Q ₀ -bar

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

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.

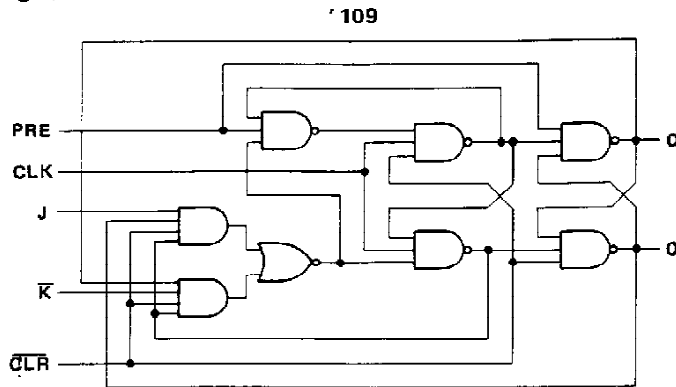
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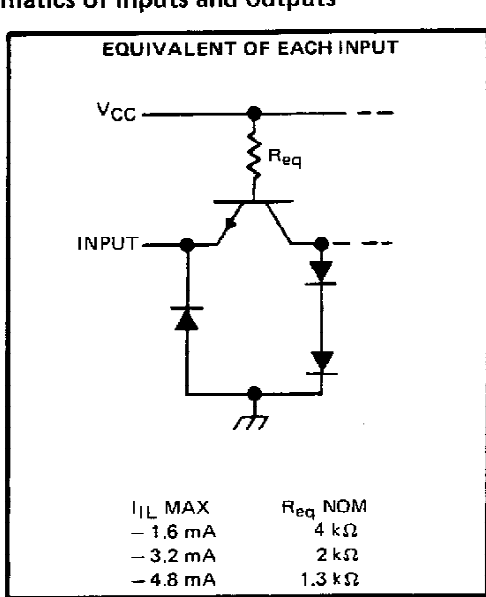
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SN54109, SN74109
DUAL J-K POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

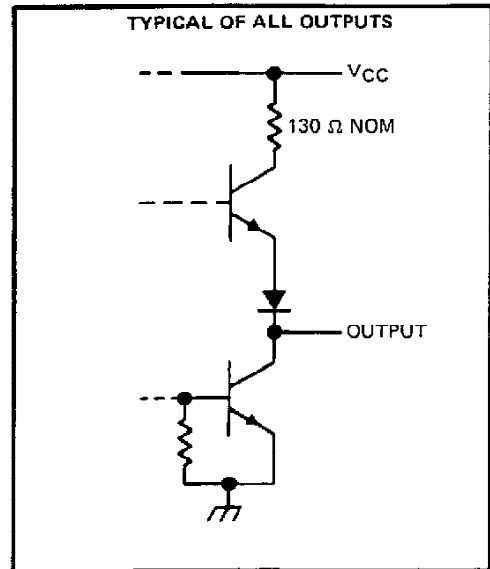
logic diagram (positive logic)



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 _{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
I _{OH} High-level output current			-0.8			-0.8	mA
I _{OL} Low-level output current			16			16	mA
t _w Pulse duration	CLK high or low		20	20			ns
	PRE or CLR low		20	20			
t _{su} Input setup time before CLK †	10			10			ns
t _h Input hold time-data after CLK †	6			6			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†	SN54109		SN74109		UNIT	
		MIN	TYP‡	MAX	MIN		TYP‡
V _{IK}	V _{CC} = MIN, I _I = -12 mA			-1.5		-1.5	V
V _{OH}	V _{CC} = MIN, V _{IH} = 2 V, V _{IL} = 0.8 V, I _{OH} = -0.8 mA	2.4	3.4	2.4	3.4		V
V _{OL}	V _{CC} = MIN, V _{IH} = 2 V, V _{IL} = 0.8 V, I _{OL} = 16 mA		0.2	0.4	0.2	0.4	V
I _I	V _{CC} = MAX, V _I = 5.5 V		1		1		mA
I _{IH}	J or K		40		40		μA
	CLR		160		160		
	PRE or CLK	V _{CC} = MAX, V _I = 2.4 V		80		80	
I _{IL}	J or K		-1.6		-1.6		mA
	CLR †		-4.8		-4.8		
	PRE †	V _{CC} = MAX, V _I = 0.4 V		-3.2		-3.2	
	CLK			-3.2		-3.2	
I _{OS} §	V _{CC} = MAX	-30		-85	-30		mA
I _{CC} #	V _{CC} = 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_{CC} = 5 V, T_A = 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_{CC} is measured with the Q and Q̄ outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f _{max}			R _L = 400 Ω, C _L = 15 pF	25	33		MHz
t _{PLH}	PRE	Q			10	15	ns
t _{PHL}		Q̄			23	35	ns
t _{PLH}	CLR	Q̄			10	15	ns
t _{PHL}		Q			17	25	ns
t _{PLH}	CLK	Q or Q̄			10	16	ns
t _{PHL}						18	28

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			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		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			0.2		
I_{IH}	J, K or CLK	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$		20		μA
	CLR or PRE			40		
I_{IL}	J, K or CLK	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$		-0.4		mA
	CLR or PRE			-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		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 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}	$\overline{\text{CLR}}, \overline{\text{PRE}}$	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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