

74HC109; 74HCT109

Dual JK flip-flop with set and reset; positive-edge-trigger

Rev. 5 — 5 August 2021

Product data sheet

1. General description

The 74HC109; 74HCT109 is a dual positive edge triggered $J\bar{K}$ flip-flop featuring individual J and \bar{K} inputs, clock (CP) inputs, set (\bar{S} D) and reset (\bar{R} D) inputs and complementary Q and \bar{Q} outputs. The set and reset are asynchronous active LOW inputs and operate independently of the clock input. The J and \bar{K} inputs control the state changes of the flip-flops as described in the mode select function table. The J and \bar{K} inputs must be stable one set-up time prior to the LOW-to-HIGH clock transition for predictable operation. The $J\bar{K}$ design allows operation as a D-type flip-flop by connecting the J and \bar{K} inputs together. This device features reduced input threshold levels to allow interfacing to TTL logic levels. Inputs also include clamp diodes, this enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

Schmitt-trigger action in the clock input makes the circuit highly tolerant to slower clock rise and fall times.

2. Features and benefits

- J and \bar{K} inputs for easy D-type flip-flop
- Toggle flip-flop or "do nothing" mode
- Wide supply voltage range:
 - For 74HC109: from 2.0 V to 6.0 V
 - For 74HCT109: from 4.5 V to 5.5 V
- CMOS low power dissipation
- High noise immunity
- Input levels:
 - For 74HC109: CMOS level
 - For 74HCT109: TTL level
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- 74HC109 complies with JEDEC standards:
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 V)
- 74HCT109 complies with JEDEC standard JESD7A (2.0 V to 6.0 V)
- ESD protection:
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC109D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT109D				
74HC109PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT109PW				

4. Functional diagram

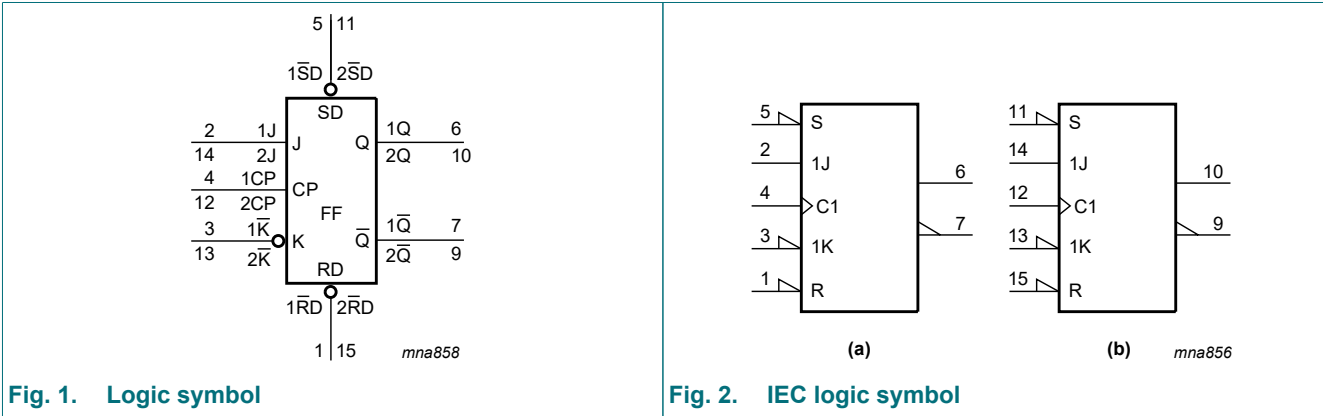


Fig. 1. Logic symbol

Fig. 2. IEC logic symbol

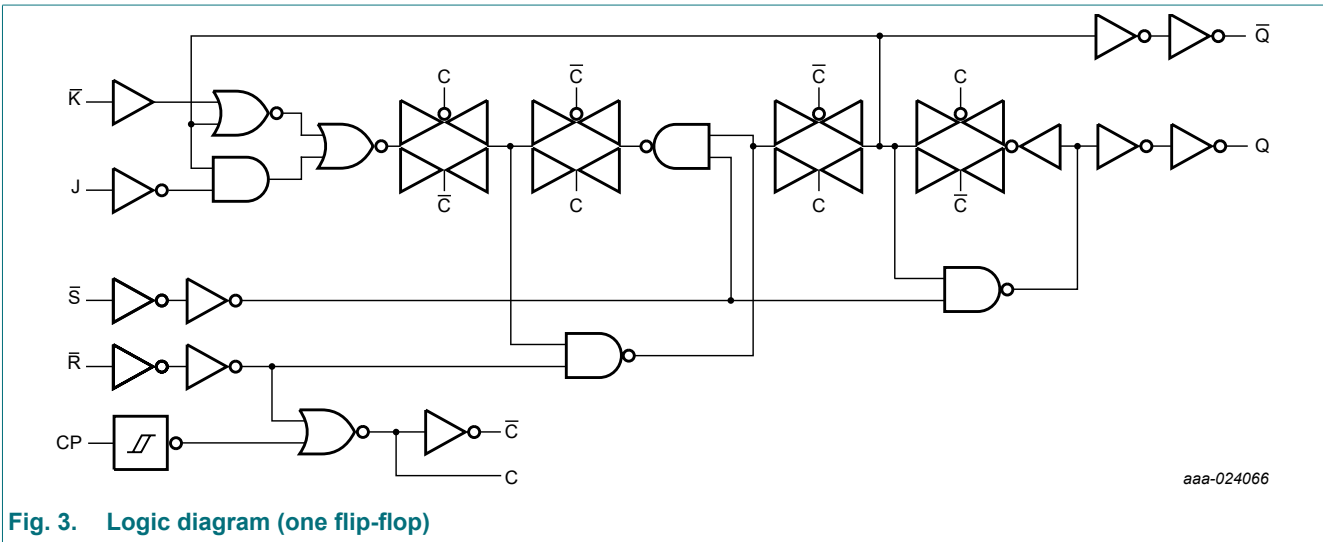
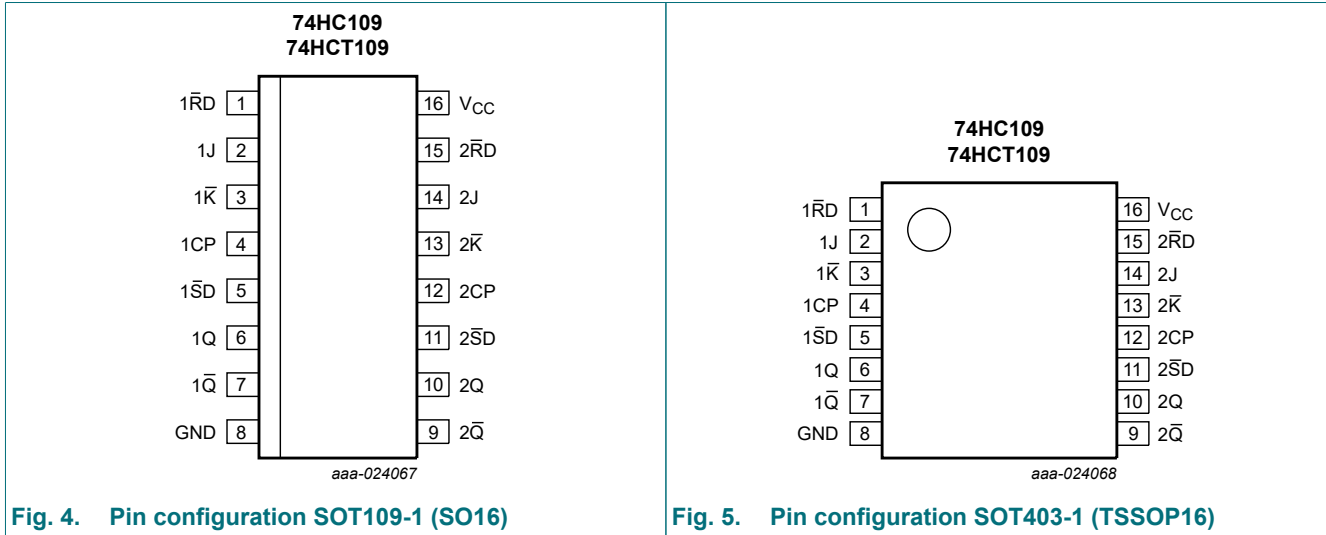


Fig. 3. Logic diagram (one flip-flop)

5. Pinning information

5.1. Pinning



5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1 $\bar{R}D$, 2 $\bar{R}D$	1, 15	asynchronous reset input (active LOW)
1J, 2J	2, 14	synchronous input
1 \bar{K} , 2 \bar{K}	3, 13	synchronous input
1CP, 2CP	4, 12	clock input (LOW-to-HIGH; edge-triggered)
1 $\bar{S}D$, 2 $\bar{S}D$	5, 11	asynchronous set input (active LOW)
1Q, 2Q	6, 10	true flip-flop output
1 \bar{Q} , 2 \bar{Q}	7, 9	complement flip-flop output
GND	8	ground (0 V)
V _{CC}	16	supply voltage

6. Functional description

Table 3. Function selection

H = HIGH voltage level; h = HIGH voltage level one set-up time before the LOW-to-HIGH CP transition;

L = LOW voltage level; l = LOW voltage level one set-up time before the LOW-to-HIGH CP transition;

q = lower case letters indicate the state of the referenced output one set-up time before the LOW-to-HIGH CP transition;

X = don't care; ↑ = LOW-to-HIGH CP transition

Operating modes	Input					Output	
	nSD	nRD	nCP	nJ	nK	nQ	nQ̄
Asynchronous set	L	H	X	X	X	H	L
Asynchronous reset	H	L	X	X	X	L	H
Undetermined	L	L	X	X	X	H	H
Toggle	H	H	↑	h	l	\bar{q}	q
Load 0 (reset)	H	H	↑	l	l	L	H
Load 1 (set)	H	H	↑	h	h	H	L
Hold no change	H	H	↑	l	h	q	\bar{q}

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		-0.5	+7	V
I_{IK}	input clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	±20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	±20	mA
I_O	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	±25	mA
I_{CC}	supply current		-	+50	mA
I_{GND}	ground current		-50	-	mA
T_{stg}	storage temperature		-65	+150	°C
P_{tot}	total power dissipation	[1]	-	500	mW

- [1] For SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C.
 For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC109			74HCT109			Unit
			Min	Typ	Max	Min	Typ	Max	
V _{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V _I	input voltage		0	-	V _{CC}	0	-	V _{CC}	V
V _O	output voltage		0	-	V _{CC}	0	-	V _{CC}	V
T _{amb}	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	V _{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V _{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V _{CC} = 6.0 V	-	-	83	-	-	-	ns/V

9. Static characteristics

Table 6. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC109										
V _{IH}	HIGH-level input voltage	V _{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V _{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V _{CC} = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V _{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V _{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = -20 μA; V _{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I _O = -20 μA; V _{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -20 μA; V _{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I _O = -4.0 mA; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = 20 μA; V _{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA; V _{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	4.0	-	40	-	80	μA
			-	3.5	-	-	-	-	-	pF
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

Dual JK flip-flop with set and reset; positive-edge-trigger

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT109										
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = -20 µA	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4.0 mA	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = 20 µA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 5.2 mA; V _{CC} = 5.5 V	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1	-	±1	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	4.0	-	40	-	80	µA
ΔI _{CC}	additional supply current	per input pin; V _I = V _{CC} - 2.1 V; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V								
		nJ, nK̄, nSD, nRD and nCP inputs	-	35	126	-	157.5	-	171.5	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit, see Fig. 8.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	Min	Max	
74HC109										
t _{pd}	propagation delay	nCP to nQ, nQ̄; see Fig. 6 [2]								
		V _{CC} = 2.0 V	-	50	175	-	220	-	265	ns
		V _{CC} = 4.5 V	-	18	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	15	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	14	30	-	37	-	45	ns
t _{PLH}	LOW to HIGH propagation delay	nSD to nQ, see Fig. 7								
		V _{CC} = 2.0 V	-	30	120	-	150	-	180	ns
		V _{CC} = 4.5 V	-	11	24	-	30	-	36	ns
		V _{CC} = 5 V; C _L = 15 pF	-	12	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	9	20	-	26	-	31	ns

Dual JK flip-flop with set and reset; positive-edge-trigger

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	Min	Max	
t _{PHL}	HIGH to LOW propagation delay	n \overline{S} D to n \overline{Q} ; see Fig. 7								
		V _{CC} = 2.0 V	-	41	155	-	195	-	235	ns
		V _{CC} = 4.5 V	-	15	31	-	39	-	47	ns
		V _{CC} = 5 V; C _L = 15 pF	-	12	-	-	-	-	-	ns
t _{PHL}	HIGH to LOW propagation delay	V _{CC} = 6.0 V	-	12	26	-	33	-	40	ns
		n \overline{R} D to n \overline{Q} ; see Fig. 7								
		V _{CC} = 2.0 V	-	41	185	-	230	-	280	ns
		V _{CC} = 4.5 V	-	15	37	-	46	-	56	ns
t _{PLH}	LOW to HIGH propagation delay	V _{CC} = 5 V; C _L = 15 pF	-	12	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	12	31	-	39	-	48	ns
		n \overline{R} D to n \overline{Q} ; see Fig. 7								
		V _{CC} = 2.0 V	-	39	170	-	215	-	255	ns
t _t	transition time	V _{CC} = 4.5 V	-	14	34	-	43	-	51	ns
		V _{CC} = 5 V; C _L = 15 pF	-	12	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	11	29	-	37	-	43	ns
		n \overline{Q} , n \overline{Q} ; see Fig. 6 [3]								
t _w	pulse width	V _{CC} = 2.0 V	-	19	75	-	95	-	110	ns
		V _{CC} = 4.5 V	-	7	15	-	19	-	22	ns
		V _{CC} = 6.0 V	-	6	13	-	16	-	19	ns
		nCP HIGH or LOW; see Fig. 6								
		V _{CC} = 2.0 V	80	19	-	100	-	120	-	ns
		V _{CC} = 4.5 V	16	7	-	20	-	24	-	ns
		V _{CC} = 6.0 V	14	6	-	17	-	20	-	ns
		n \overline{S} D, n \overline{R} D HIGH or LOW; see Fig. 7								
t _{rec}	recovery time	V _{CC} = 2.0 V	80	14	-	100	-	120	-	ns
		V _{CC} = 4.5 V	16	5	-	20	-	24	-	ns
		V _{CC} = 6.0 V	14	4	-	17	-	20	-	ns
		n \overline{S} D, n \overline{R} D to nCP; see Fig. 7								
t _{rec}	recovery time	V _{CC} = 2.0 V	70	19	-	90	-	105	-	ns
		V _{CC} = 4.5 V	14	7	-	18	-	21	-	ns
		V _{CC} = 6.0 V	12	6	-	15	-	18	-	ns

Dual JK flip-flop with set and reset; positive-edge-trigger

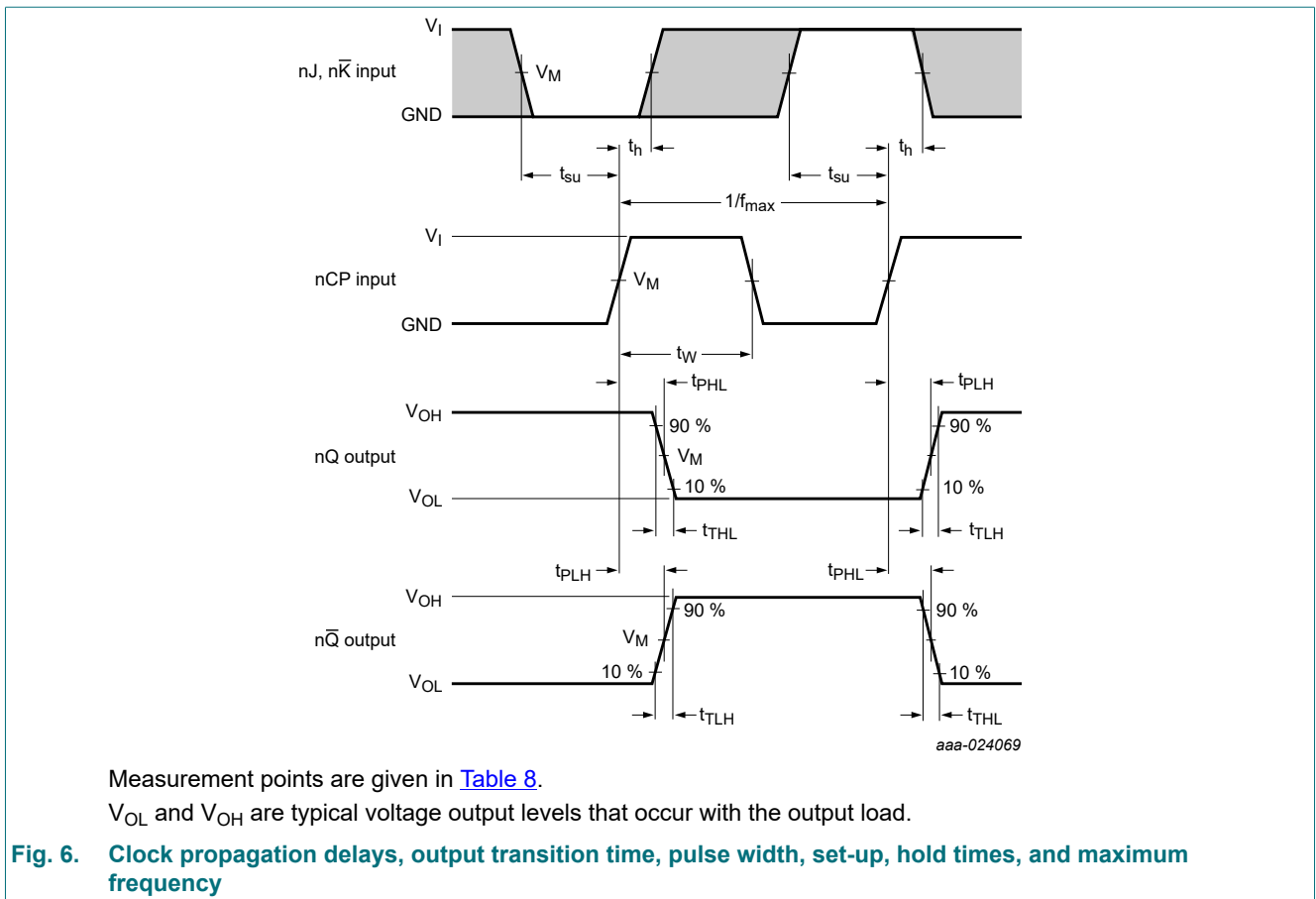
Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	Min	Max	
t _{su}	set-up time	nJ and n \bar{K} to nCP; see Fig. 6								
		V _{CC} = 2.0 V	70	17	-	90	-	105	-	ns
		V _{CC} = 4.5 V	14	6	-	18	-	21	-	ns
		V _{CC} = 6.0 V	12	5	-	15	-	18	-	ns
t _h	hold time	nJ and n \bar{K} to nCP; see Fig. 6								
		V _{CC} = 2.0 V	5	0	-	5	-	5	-	ns
		V _{CC} = 4.5 V	5	0	-	5	-	5	-	ns
		V _{CC} = 6.0 V	5	0	-	5	-	5	-	ns
f _{max}	maximum frequency	nCP; see Fig. 6								
		V _{CC} = 2.0 V	6	22	-	5	-	4	-	MHz
		V _{CC} = 4.5 V	30	68	-	24	-	20	-	MHz
		V _{CC} = 5 V; C _L = 15 pF	-	75	-	-	-	-	-	MHz
		V _{CC} = 6.0 V	35	81	-	28	-	24	-	MHz
C _{PD}	power dissipation capacitance	C _L = 50 pF; f = 1 MHz; V _I = GND to V _{CC} [4]	-	20	-	-	-	-	-	pF
74HCT109										
t _{pd}	propagation delay	nCP to nQ, n \bar{Q} ; see Fig. 6 [2]								
		V _{CC} = 4.5 V	-	20	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	17	-	-	-	-	-	ns
t _{PLH}	LOW to HIGH propagation delay	n \bar{S} D to nQ, see Fig. 7								
		V _{CC} = 4.5 V	-	13	26	-	33	-	39	ns
		V _{CC} = 5 V; C _L = 15 pF	-	14	-	-	-	-	-	ns
t _{PHL}	HIGH to LOW propagation delay	n \bar{S} D to n \bar{Q} ; see Fig. 7								
		V _{CC} = 4.5 V	-	19	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	14	-	-	-	-	-	ns
t _{PHL}	HIGH to LOW propagation delay	n \bar{R} D to nQ; see Fig. 7								
		V _{CC} = 4.5 V	-	19	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	15	-	-	-	-	-	ns
t _{PLH}	LOW to HIGH propagation delay	n \bar{R} D to n \bar{Q} ; see Fig. 7								
		V _{CC} = 4.5 V	-	16	32	-	40	-	48	ns
		V _{CC} = 5 V; C _L = 15 pF	-	15	-	-	-	-	-	ns
t _t	transition time	nQ, n \bar{Q} ; V _{CC} = 4.5 V; see Fig. 6 [3]	-	7	15	-	19	-	22	ns
t _w	pulse width	nCP HIGH or LOW; V _{CC} = 4.5 V; see Fig. 6	18	9	-	23	-	27	-	ns
		n \bar{S} D, n \bar{R} D HIGH or LOW; V _{CC} = 4.5 V; see Fig. 7	16	8	-	20	-	24	-	ns
t _{rec}	recovery time	n \bar{S} D, n \bar{R} D to nCP; V _{CC} = 4.5 V; see Fig. 7	16	8	-	20	-	24	-	ns

Dual JK flip-flop with set and reset; positive-edge-trigger

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	Min	Max	
t _{su}	set-up time	nJ and nK̄ to nCP; V _{CC} = 4.5 V; see Fig. 6	18	8	-	23	-	27	-	ns
t _h	hold time	nJ and nK̄ to nCP; V _{CC} = 4.5 V; see Fig. 6	3	-3	-	3	-	3	-	ns
f _{max}	maximum frequency	nCP; see Fig. 6								
		V _{CC} = 4.5 V	27	55	-	22	-	18	-	MHz
		V _{CC} = 5 V; C _L = 15 pF	-	61	-	-	-	-	-	MHz
C _{PD}	power dissipation capacitance	C _L = 50 pF; f = 1 MHz; V _I = GND to V _{CC} - 1.5 V	[4]	-	22	-	-	-	-	pF

- [1] All typical values are measured at T_{amb} = 25 °C.
- [2] t_{pd} is the same as t_{PLH} and t_{PHL}.
- [3] t_i is the same as t_{THL} and t_{TLH}.
- [4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz;
 f_o = output frequency in MHz;
 C_L = output load capacitance in pF;
 V_{CC} = supply voltage in V;
 N = number of inputs switching;
 $\sum(C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

10.1. Waveforms and test circuit



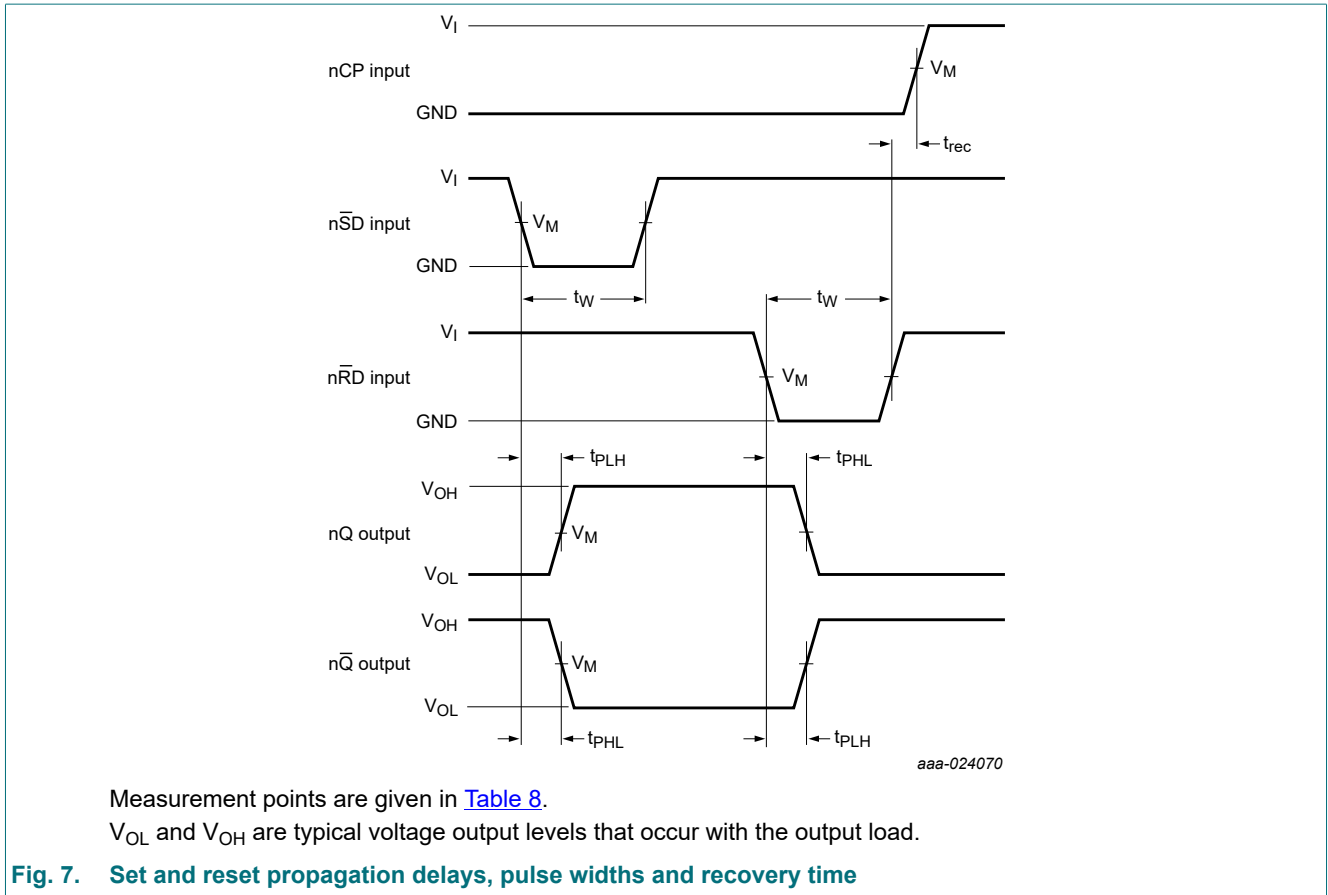


Table 8. Measurement points

Type	Input	Output
	V_M	V_M
74HC109	$0.5V_{CC}$	$0.5V_{CC}$
74HCT109	1.3 V	1.3 V

Dual JK flip-flop with set and reset; positive-edge-trigger

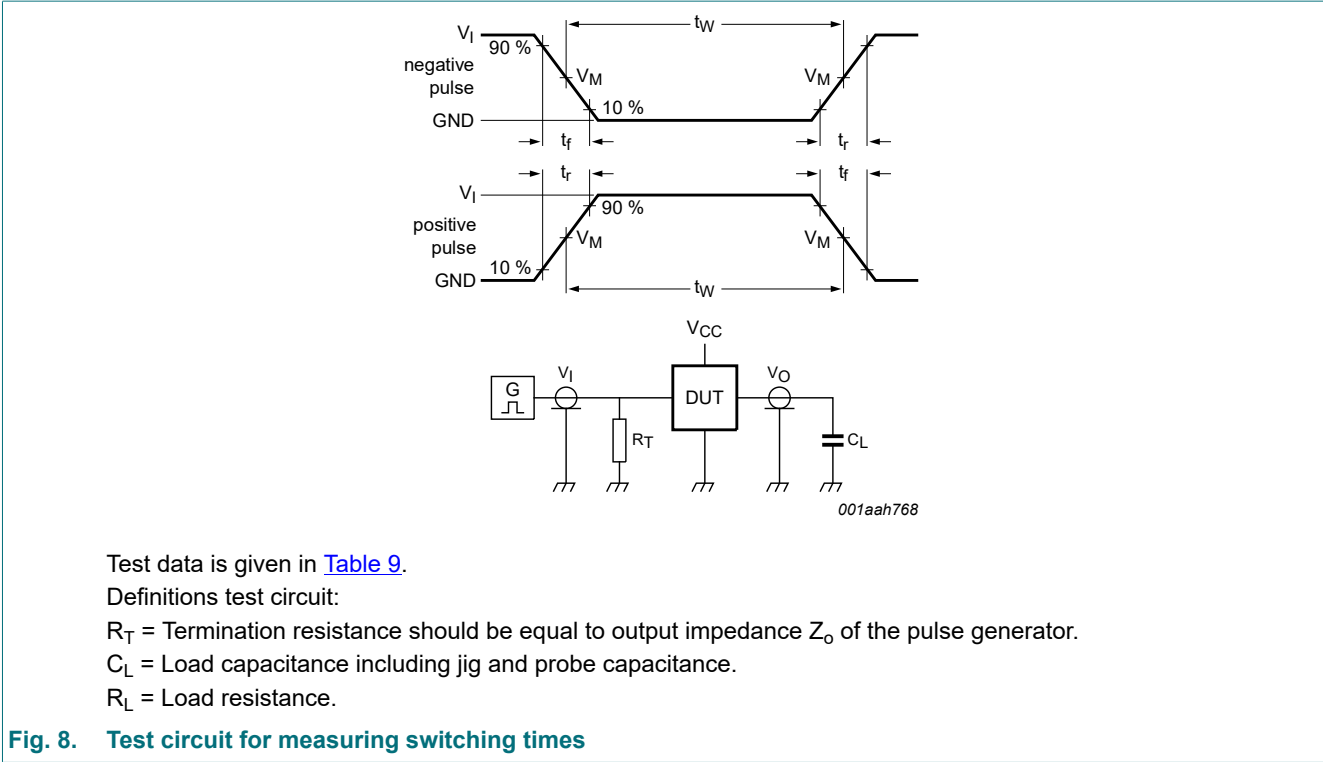


Fig. 8. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load	Test
	V_I	t_r, t_f	C_L	
74HC109	V_{CC}	6 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}
74HCT109	3 V	6 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}

11. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



Fig. 9. Package outline SOT109-1 (SO16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1



Fig. 10. Package outline SOT403-1 (TSSOP16)

12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
TTL	Transistor-Transistor Logic

13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT109 v.5	20210805	Product data sheet	-	74HC_HCT109 v.4
Modifications:	<ul style="list-style-type: none"> Type number 74HC109PW (SOT403-1/TSSOP16) added. Type numbers 74HC109DB and 74HCT109DB (SOT338-1/SSOP16) removed. Section 1 and Section 2 updated. 			
74HC_HCT109 v.4	20200401	Product data sheet	-	74HC_HCT109 v.3
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Table 4: Derating values for P_{tot} total power dissipation updated. 			
74HC_HCT109 v.3	20160801	Product data sheet	-	74HC_HCT109_CNV v.2
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. Legal texts have been adapted to the new company name where appropriate. 			
74HC_HCT109_CNV v.2	19971125	Product specification	-	-

14. Legal information

Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

Definitions

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