

74HC109-Q100; 74HCT109-Q100

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

Rev. 2 — 1 April 2020

Product data sheet

1. General description

The 74HC109-Q100; 74HCT109-Q100 is a dual positive edge triggered \overline{JK} flip-flop featuring individual nJ and n \overline{K} inputs. It has clock (nCP) inputs, set (n \overline{SD}) and reset (n \overline{RD}) inputs and complementary nQ and n \overline{Q} outputs. The set and reset are asynchronous active LOW inputs and operate independently of the clock input. The nJ and n \overline{K} inputs control the state changes of the flip-flops as described in the mode select function table. The nJ and n \overline{K} inputs must be stable one set-up time prior to the LOW-to-HIGH clock transition for predictable operation. The \overline{JK} design allows operation as a D-type flip-flop by connecting the nJ and n \overline{K} inputs together. Inputs include clamp diodes. It 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.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

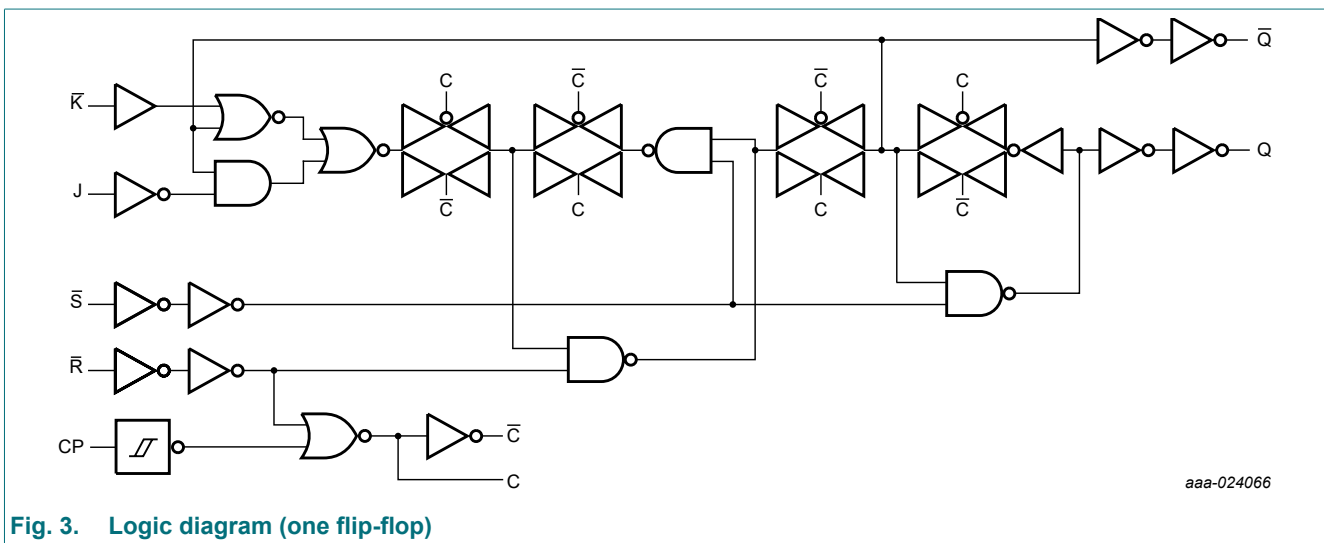
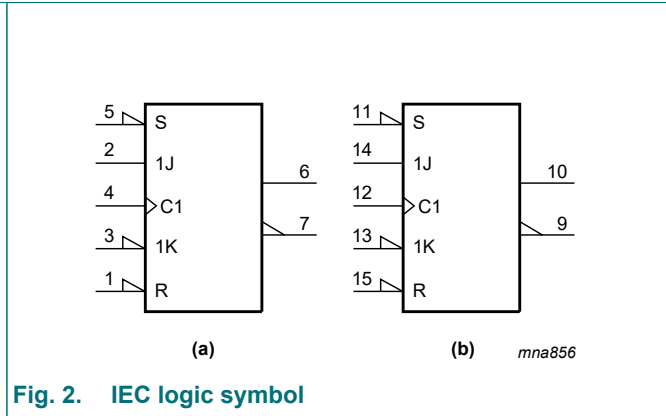
- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- Input levels:
 - For 74HC109-Q100: CMOS level
 - For 74HCT109-Q100: TTL level
- J and \overline{K} inputs for easy D-type flip-flop
- Toggle flip-flop or "do nothing" mode
- Specified in compliance with JEDEC standard no. 7A
- ESD protection:
 - MIL-STD-883, method 3015 exceeds 2000 V
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)

3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC109D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT109D-Q100				
74HCT109PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

4. Functional diagram



5. Pinning information

5.1. Pinning

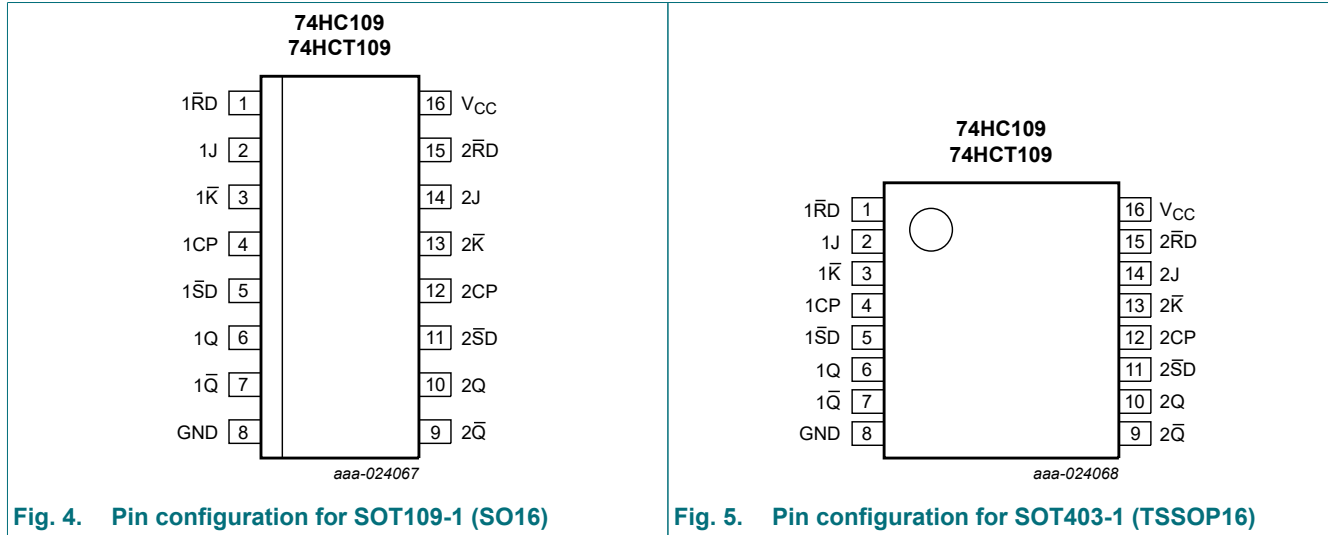


Fig. 4. Pin configuration for SOT109-1 (SO16)

Fig. 5. Pin configuration for SOT403-1 (TSSOP16)

5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1RD, 2RD	1, 15	asynchronous reset input (active LOW)
1J, 2J	2, 14	synchronous input
1K, 2K	3, 13	synchronous input
1CP, 2CP	4, 12	clock input (LOW-to-HIGH; edge-triggered)
1SD, 2SD	5, 11	asynchronous set input (active LOW)
1Q, 2Q	6, 10	true flip-flop output
1Q-bar, 2Q-bar	7, 9	complement flip-flop output
GND	8	ground (0 V)
VCC	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	nQ
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-Q100			74HCT109-Q100			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-Q100										
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 _l	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1	-	±1	μA
		V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	4.0	-	40	-	80	μA
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-Q100										
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-Q100										
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
		V _{CC} = 6.0 V	-	12	26	-	33	-	40	ns
t _{PHL}	HIGH to LOW propagation delay	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
		V _{CC} = 5 V; C _L = 15 pF	-	12	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	12	31	-	39	-	48	ns
t _{PLH}	LOW to HIGH propagation delay	n \overline{R} D to n \overline{Q} ; see Fig. 7								
		V _{CC} = 2.0 V	-	39	170	-	215	-	255	ns
		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
t _t	transition time	n \overline{Q} , n \overline{Q} ; see Fig. 6 [3]								
		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
t _w	pulse width	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								
		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	
t _{rec}	recovery time	n \overline{S} D, n \overline{R} D to nCP; see Fig. 7								
		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

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-Q100										
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

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_t is the same as t_{THL} and t_{TLH}.
- [4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ 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;
 Σ(C_L × V_{CC}² × f_o) = sum of outputs.

10.1. Waveforms and test circuit



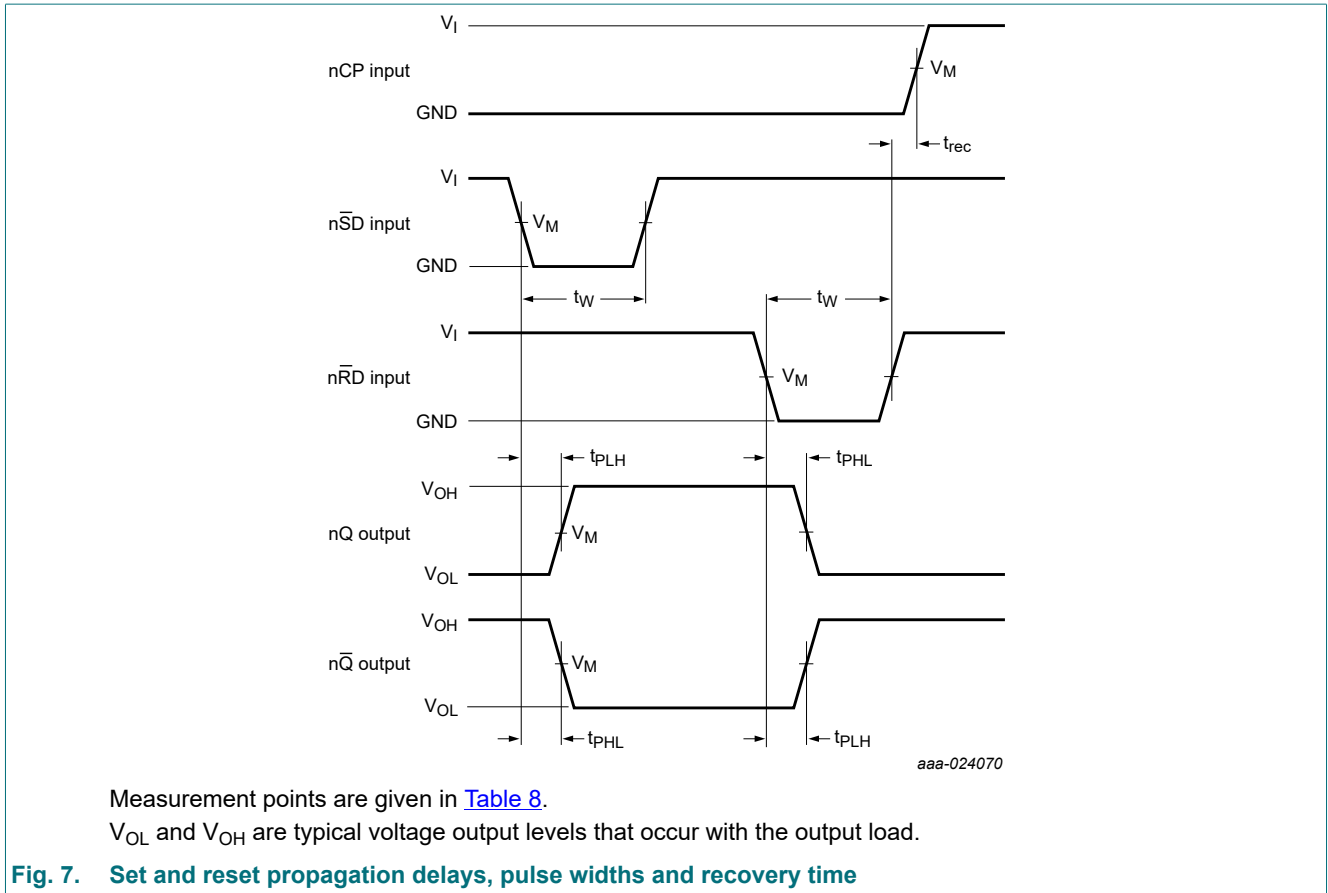
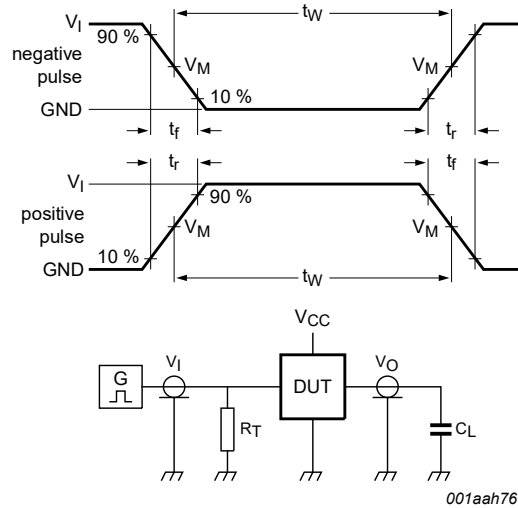


Table 8. Measurement points

Type	Input	Output
	V_M	V_M
74HC109-Q100	$0.5V_{CC}$	$0.5V_{CC}$
74HCT109-Q100	1.3 V	1.3 V



Test data is given in [Table 9](#).

Definitions test circuit:

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

R_L = Load resistance.

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-Q100	V_{CC}	6 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}
74HCT109-Q100	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

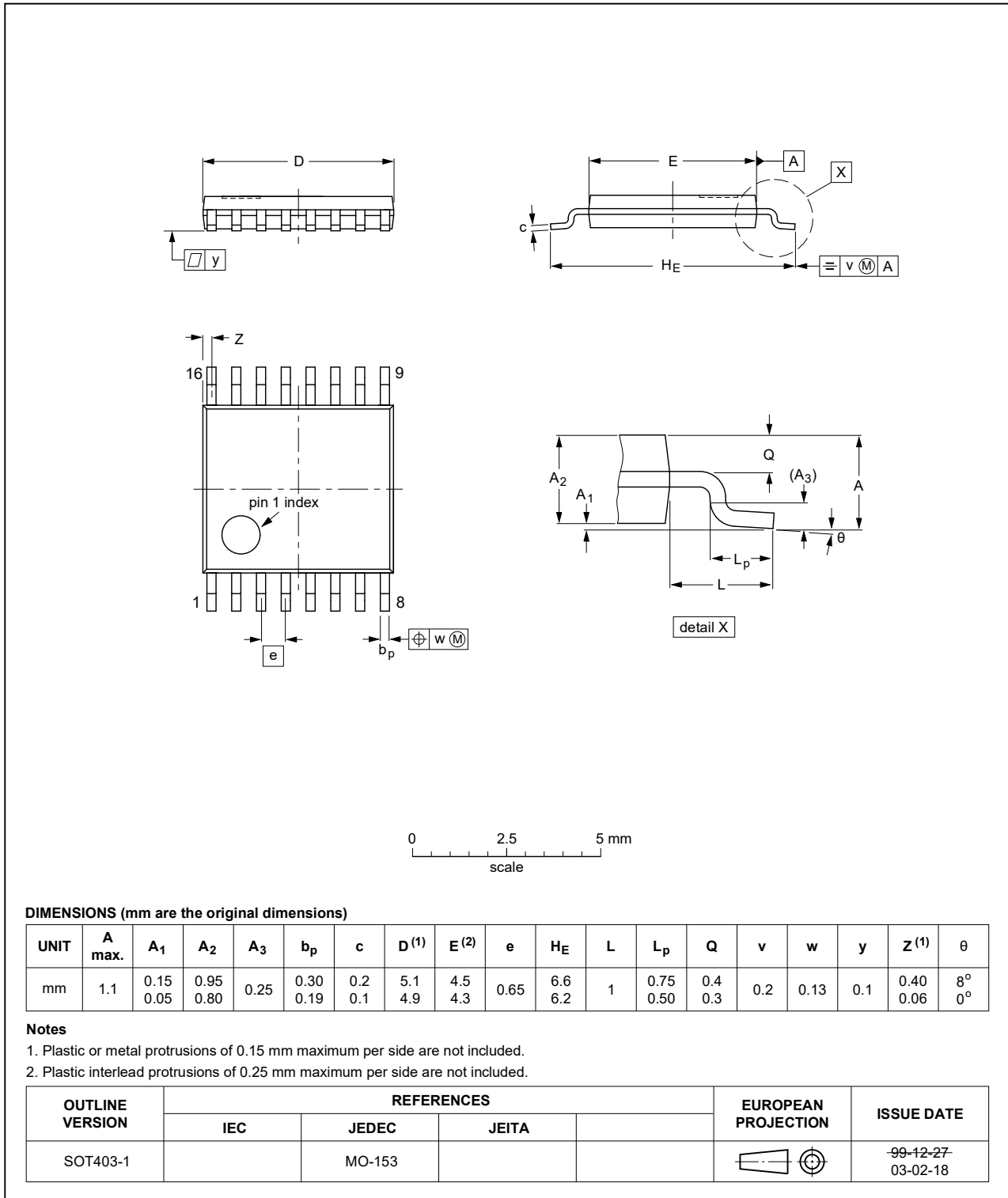


Fig. 10. Package outline SOT403-1 (TSSOP16)

12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
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_Q100 v.2	20200401	Product data sheet	-	74HC_HCT109_Q100 v.1
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. Type number 74HCT109PW-Q100 (SOT403-1/TSSOP16) added. Table 4: Derating values for P_{tot} total power dissipation updated. 			
74HC_HCT109_Q100 v.1	20160928	Product data sheet	-	-

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>.

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Date of release: 1 April 2020
