

DATA SHEET

74LV109

Dual \overline{JK} flip-flop with set and reset;
positive-edge trigger

Product specification
Supersedes data of 1997 Jun 06
IC24 Data Handbook

1998 Apr 20

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

74LV109

FEATURES

- Optimized for low voltage applications: 1.0 to 3.6 V
- Accepts TTL input levels between $V_{CC} = 2.7$ V and $V_{CC} = 3.6$ V
- Typical V_{OLP} (output ground bounce) < 0.8 V at $V_{CC} = 3.3$ V, $T_{amb} = 25^{\circ}\text{C}$
- Typical V_{OHV} (output V_{OH} undershoot) > 2 V at $V_{CC} = 3.3$ V, $T_{amb} = 25^{\circ}\text{C}$
- Output capability: standard
- I_{CC} category: flip-flops

DESCRIPTION

The 74LV109 is a low-voltage Si-gate CMOS device that is pin and function compatible with 74HC/HCT109.

The 74LV109 is a dual positive-edge triggered JK-type flip-flop featuring individual J, K inputs, clock (CP) inputs, set (\overline{S}_D) and reset (\overline{R}_D) inputs; also complementary Q and \overline{Q} outputs.

The set and reset are asynchronous active LOW inputs and operate independently of the clock input.

The J and K inputs control the state changes of the flip-flops as described in the mode select function table. The J and K inputs must be stable one set-up time prior to the LOW-to-HIGH clock transition for predictable operation.

The JK design allows operation as a D-type flip-flop by tying the J and K inputs together.

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

QUICK REFERENCE DATA

GND = 0 V; $T_{amb} = 25^{\circ}\text{C}$; $t_r = t_f \leq 2.5$ ns

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
t_{PHL}/t_{PLH}	Propagation delay nCP to nQ, n \overline{Q} n \overline{S}_D to nQ, n \overline{Q} n \overline{R}_D to nQ, n \overline{Q}	$C_L = 15$ pF; $V_{CC} = 3.3$ V	14 12 12	ns
f_{max}	Maximum clock frequency		77	MHz
C_I	Input capacitance		3.5	pF
C_{PD}	Power dissipation capacitance per flip-flop	$V_I = \text{GND to } V_{CC}^1$	20	pF

NOTE:

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW)

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz; C_L = output load capacitance in pF;

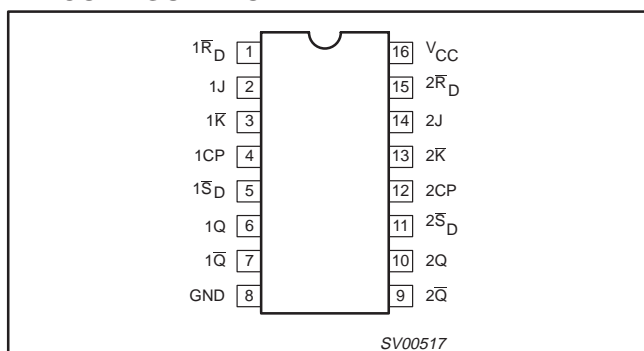
f_o = output frequency in MHz; V_{CC} = supply voltage in V;

$\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.

ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	PKG. DWG. #
16-Pin Plastic DIL	-40°C to $+125^{\circ}\text{C}$	74LV109 N	74LV109 N	SOT38-4
16-Pin Plastic SO	-40°C to $+125^{\circ}\text{C}$	74LV109 D	74LV109 D	SOT109-1
16-Pin Plastic SSOP Type II	-40°C to $+125^{\circ}\text{C}$	74LV109 DB	74LV109 DB	SOT338-1
16-Pin Plastic TSSOP Type I	-40°C to $+125^{\circ}\text{C}$	74LV109 PW	74LV109PW DH	SOT403-1

PIN CONFIGURATION



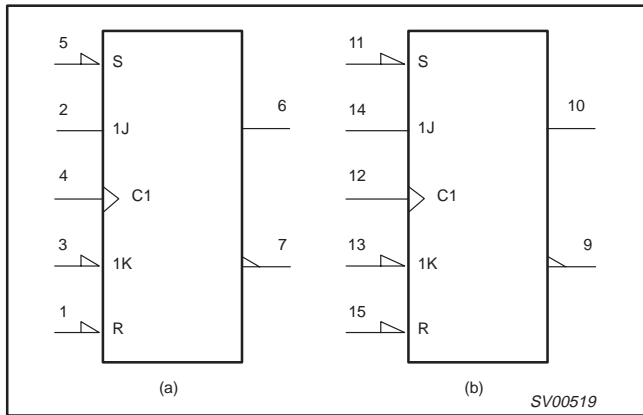
PIN DESCRIPTION

PIN NUMBER	SYMBOL	FUNCTION
1, 15	$1\overline{R}_D, 2\overline{R}_D$	Asynchronous reset input (active LOW)
2, 14, 3, 13	$1J, 2J, 1\overline{K}, 2\overline{K}$	Synchronous inputs; flip-flops 1 and 2
4, 12	$1CP, 2CP$	Clock input (LOW-to-HIGH, edge-triggered)
5, 11	$1\overline{S}_D, 2\overline{S}_D$	Asynchronous set inputs (active LOW)
6, 10	$1Q, 2Q$	True flip-flop outputs
7, 9	$1\overline{Q}, 2\overline{Q}$	Complement flip-flop outputs
8	GND	Ground (0 V)
16	V_{CC}	Positive supply voltage

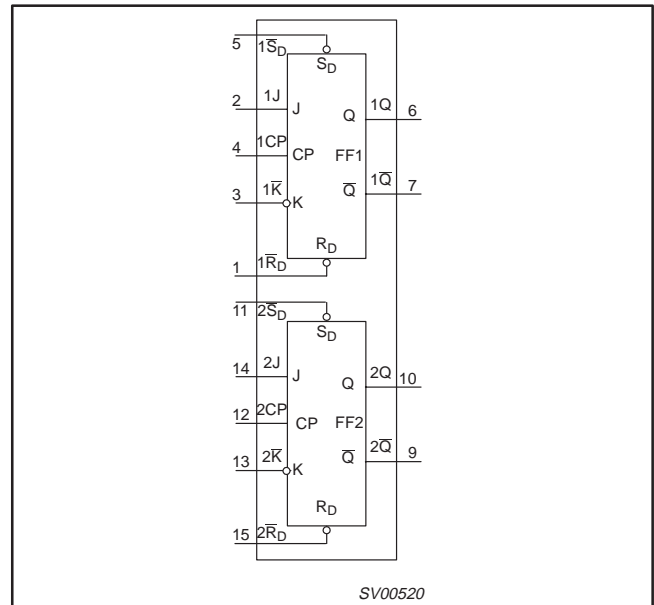
Dual JK flip-flop with set and reset; positive-edge trigger

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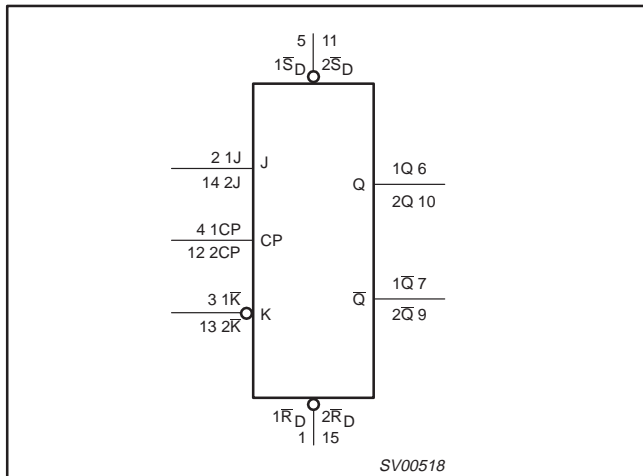
LOGIC SYMBOL (IEEE/IEC)



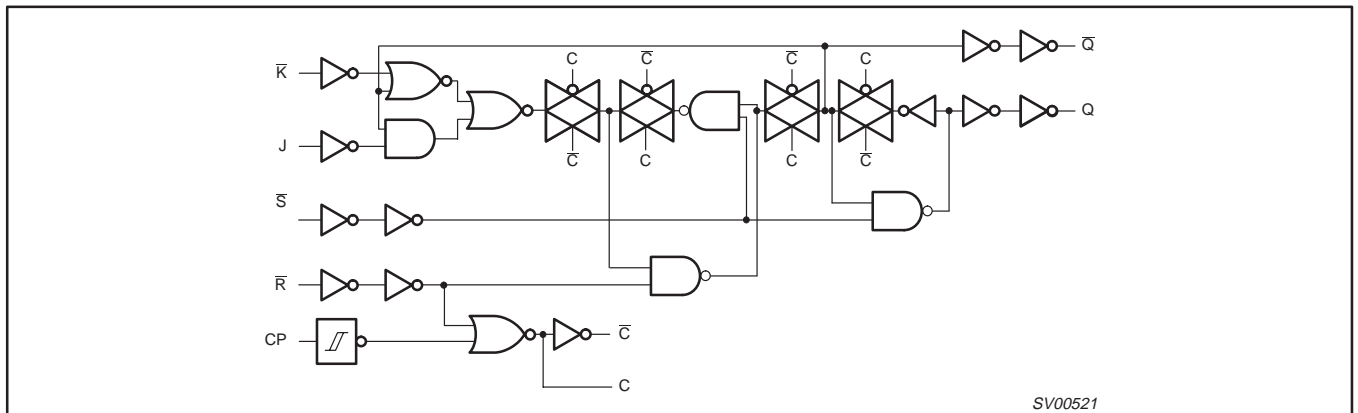
FUNCTIONAL DIAGRAM



LOGIC SYMBOL



LOGIC DIAGRAM



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FUNCTION TABLE

OPERATING MODES	INPUTS					OUTPUTS	
	nS _D	nR _D	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	q̄	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	q̄

NOTES:

H = HIGH voltage level

h = HIGH voltage level one set-up time prior to the LOW-to-HIGH CP transition

L = LOW voltage level

l = LOW voltage level one set-up time prior to the LOW-to-HIGH CP transition

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

X = don't care

↑ = LOW-to-HIGH CP transition

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
V _{CC}	DC supply voltage	See Note 1	1.0	3.3	3.6	V
V _I	Input voltage		0	–	V _{CC}	V
V _O	Output voltage		0	–	V _{CC}	V
T _{amb}	Operating ambient temperature range in free air	See DC and AC characteristics	-40 -40		+85 +125	°C
t _r , t _f	Input rise and fall times except for Schmitt-trigger inputs	V _{CC} = 1.0V to 2.0V V _{CC} = 2.0V to 2.7V V _{CC} = 2.7V to 3.6V	– – –	– – –	500 200 100	ns/V

NOTE:

1. The LV is guaranteed to function down to V_{CC} = 1.0V (input levels GND or V_{CC}); DC characteristics are guaranteed from V_{CC} = 1.2V to V_{CC} = 3.6V.ABSOLUTE MAXIMUM RATINGS^{1, 2}

In accordance with the Absolute Maximum Rating System (IEC 134).

Voltages are referenced to GND (ground = 0V).

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V _{CC}	DC supply voltage		-0.5 to +4.6	V
±I _{IK}	DC input diode current	V _I < -0.5 or V _I > V _{CC} + 0.5V	20	mA
±I _{OK}	DC output diode current	V _O < -0.5 or V _O > V _{CC} + 0.5V	50	mA
±I _O	DC output source or sink current – standard outputs	-0.5V < V _O < V _{CC} + 0.5V	25	mA
±I _{GND} , ±I _{CC}	DC V _{CC} or GND current for types with – standard outputs		50	mA
T _{stg}	Storage temperature range		-65 to +150	°C
P _{TOT}	Power dissipation per package – plastic DIL – plastic mini-pack (SO) – plastic shrink mini-pack (SSOP and TSSOP)	for temperature range: -40 to +125°C above +70°C derate linearly with 12 mW/K above +70°C derate linearly with 8 mW/K above +60°C derate linearly with 5.5 mW/K	750 500 400	mW

NOTE:

- Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

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DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNIT
			-40°C to +85°C			-40°C to +125°C		
			MIN	TYP ¹	MAX	MIN	MAX	
V _{IH}	HIGH level Input voltage	V _{CC} = 1.2 V	0.9			0.9		V
		V _{CC} = 2.0 V	1.4			1.4		
		V _{CC} = 2.7 to 3.6 V	2.0			2.0		
V _{IL}	LOW level Input voltage	V _{CC} = 1.2 V			0.3		0.3	V
		V _{CC} = 2.0 V			0.6		0.6	
		V _{CC} = 2.7 to 3.6 V			0.8		0.8	
V _{OH}	HIGH level output voltage; all outputs	V _{CC} = 1.2 V; V _I = V _{IH} or V _{IL} ; -I _O = 100µA		1.2				V
		V _{CC} = 2.0 V; V _I = V _{IH} or V _{IL} ; -I _O = 100µA	1.8	2.0		1.8		
		V _{CC} = 2.7 V; V _I = V _{IH} or V _{IL} ; -I _O = 100µA	2.5	2.7		2.5		
		V _{CC} = 3.0 V; V _I = V _{IH} or V _{IL} ; -I _O = 100µA	2.8	3.0		2.8		
V _{OH}	HIGH level output voltage; STANDARD outputs	V _{CC} = 3.0 V; V _I = V _{IH} or V _{IL} ; -I _O = 6mA	2.40	2.82		2.20		V
V _{OL}	LOW level output voltage; all outputs	V _{CC} = 1.2 V; V _I = V _{IH} or V _{IL} ; I _O = 100µA		0				V
		V _{CC} = 2.0 V; V _I = V _{IH} or V _{IL} ; I _O = 100µA		0	0.2		0.2	
		V _{CC} = 2.7 V; V _I = V _{IH} or V _{IL} ; I _O = 100µA		0	0.2		0.2	
		V _{CC} = 3.0 V; V _I = V _{IH} or V _{IL} ; I _O = 100µA		0	0.2		0.2	
V _{OL}	LOW level output voltage; STANDARD outputs	V _{CC} = 3.0 V; V _I = V _{IH} or V _{IL} ; I _O = 6mA		0.25	0.40		0.50	V
I _I	Input leakage current	V _{CC} = 3.6 V; V _I = V _{CC} or GND			1.0		1.0	µA
I _{CC}	Quiescent supply current; flip-flops	V _{CC} = 3.6V; V _I = V _{CC} or GND; I _O = 0			20.0		80	µA
ΔI _{CC}	Additional quiescent supply current per input	V _{CC} = 2.7 V to 3.6 V; V _I = V _{CC} - 0.6 V			500		850	µA

NOTE:1. All typical values are measured at T_{amb} = 25°C.**AC CHARACTERISTICS**GND = 0V; t_r = t_f ≤ 2.5ns; C_L = 50pF; R_L = 1KΩ

SYMBOL	PARAMETER	WAVEFORM	CONDITION	LIMITS					UNIT
				-40 to +85 °C			-40 to +125 °C		
				MIN	TYP ¹	MAX	MIN	MAX	
t _{PHL} /t _{PLH}	Propagation delay nCP to nQ, nQ̄	Figure 1	V _{CC} (V)						ns
			1.2		90				
			2.0		31	58		70	
			2.7		23	43		51	
		3.0 to 3.6		18 ²	34		41		
t _{PLH}	Propagation delay nS _D to nQ	Figure 2	V _{CC} (V)						ns
			1.2		55				
			2.0		19	36		44	
			2.7		14	26		33	
		3.0 to 3.6		10 ²	21		26		

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AC CHARACTERISTICS (Continued)GND = 0V; $t_r = t_f \leq 2.5\text{ns}$; $C_L = 50\text{pF}$; $R_L = 1\text{k}\Omega$

SYMBOL	PARAMETER	WAVEFORM	CONDITION	LIMITS					UNIT
				-40 to +85 °C			-40 to +125 °C		
				V _{CC} (V)	MIN	TYP ¹	MAX	MIN	
t _{PHL}	Propagation delay nS _D to nQ	Figure 2	1.2		75				ns
			2.0		26	46		60	
			2.7		19	36		44	
			3.0 to 3.6		17 ²	29		35	
t _{PHL}	Propagation delay nR _D to nQ	Figure 2	1.2		75				ns
			2.0		26	46		60	
			2.7		19	36		44	
			3.0 to 3.6		15 ²	29		35	
t _{PLH}	Propagation delay nR _D to nQ	Figure 2	1.2		70				ns
			2.0		24	44		54	
			2.7		18	33		40	
			3.0 to 3.6		13 ²	26		32	
t _w	Clock pulse width HIGH or LOW	Figure 1	2.0	34	12		41		ns
			2.7	25	9		30		
			3.0 to 3.6	20	7 ²		24		
t _w	Set or reset pulse width HIGH or LOW	Figure 2	2.0	34	9		41		ns
			2.7	25	6		30		
			3.0 to 3.6	20	5 ²		24		
t _{rem}	Removal time nS _D , nR _D to nCP	Figure 2	1.2		35				ns
			2.0	24	12		29		
			2.7	18	9		21		
			3.0 to 3.6	14	7 ²		17		
t _{su}	Set-up time nJ, nK to CP	Figure 1	1.2		30				ns
			2.0	22	10		26		
			2.7	16	8		19		
			3.0 to 3.6	13	6 ²		15		
t _h	Hold time nJ, nK to nCP	Figure 1	1.2		-5				ns
			2.0	5	-2		5		
			2.7	5	-1		5		
			3.0 to 3.6	5	0 ²		5		
f _{max}	Maximum clock pulse frequency	Figure 1	2.0	14	40		12		MHz
			2.7	19	58		16		
			3.0 to 3.6	24	70 ²		20		

NOTES:

1. Unless otherwise stated, all typical values are measured at T_{amb} = 25°C
2. Typical values are measured at V_{CC} = 3.3 V.

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AC WAVEFORMS

$V_M = 1.5\text{ V}$ at $V_{CC} \geq 2.7\text{ V}$;
 $V_M = 0.5 \times V_{CC}$ at $V_{CC} < 2.7\text{ V}$;
 V_{OL} and V_{OH} are the typical output voltage drop that occur with the output load.

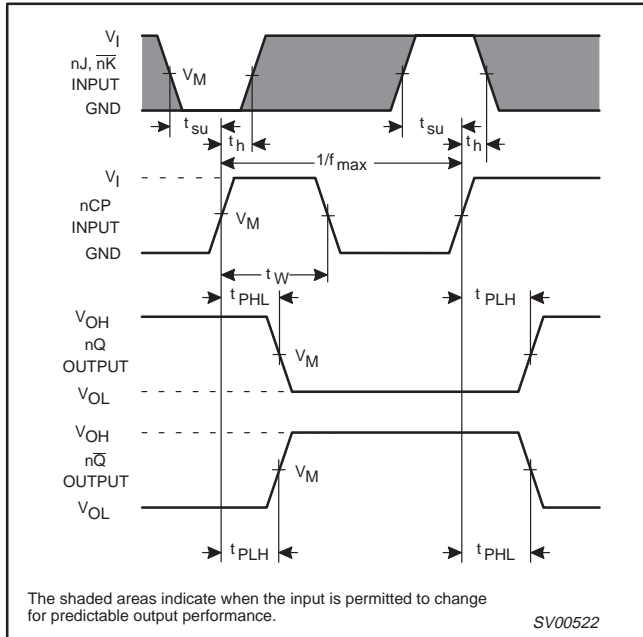


Figure 1. Clock (nCP) to output (nQ, nQ) propagation delays, the clock pulse width, the nJ and nK to nCP set-up, the nCP to nJ, nK hold times and the maximum clock pulse frequency.

TEST CIRCUIT

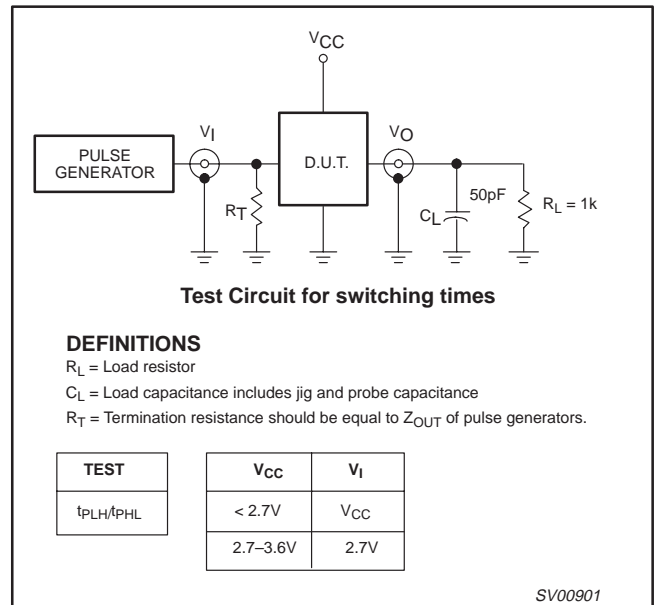


Figure 3. Load circuitry for switching times.

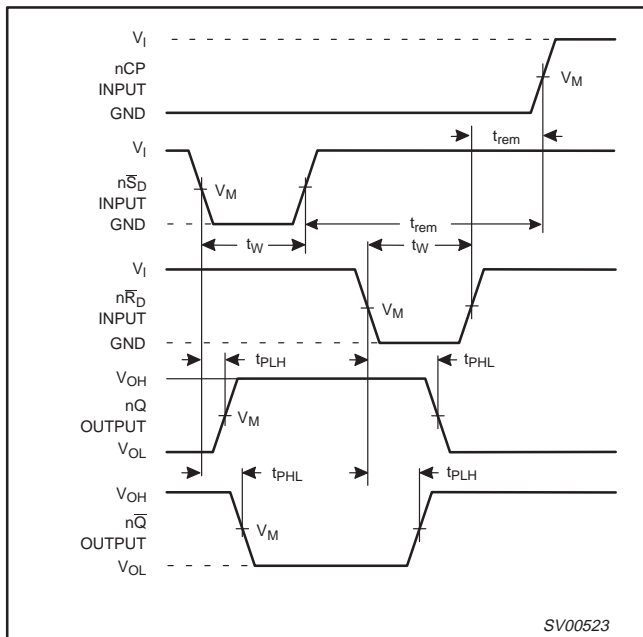


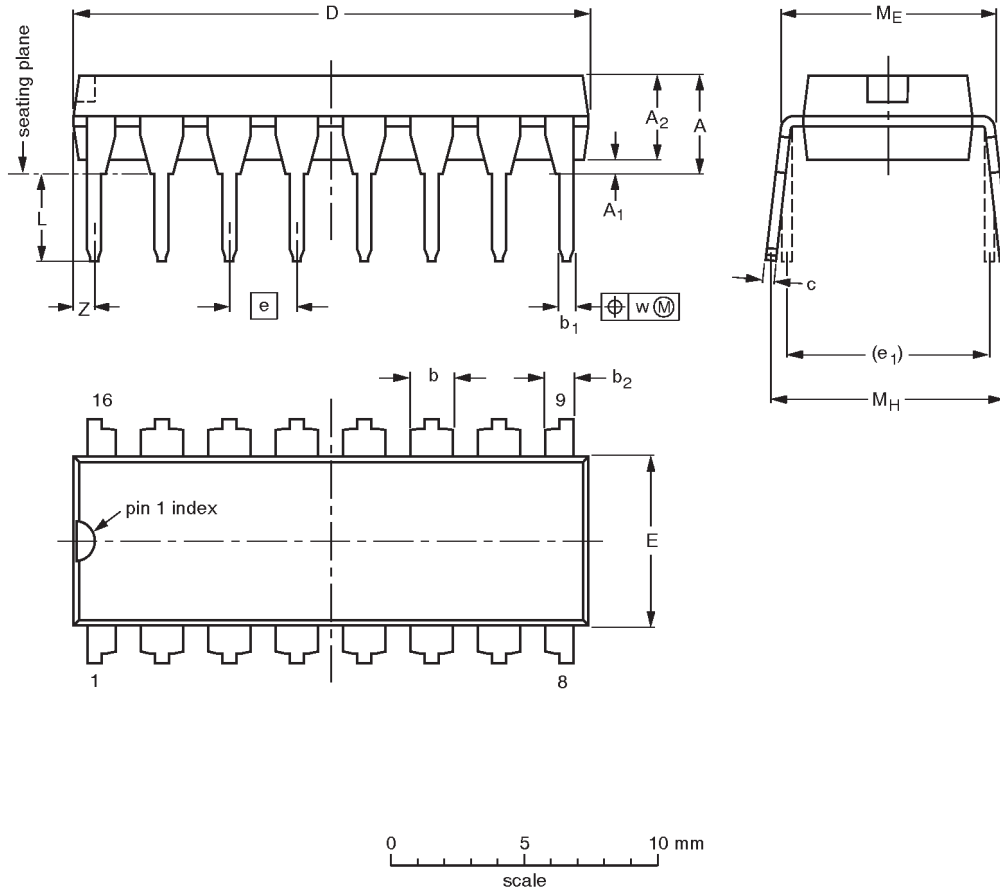
Figure 2. Set (nS \bar{D}) and reset (nR \bar{D}) input to output (nQ, nQ) propagation delays, the set and reset pulse widths and the nR \bar{D} , nS \bar{D} to nCP removal time.

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DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	b ₂	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	1.25 0.85	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	0.76
inches	0.17	0.020	0.13	0.068 0.051	0.021 0.015	0.049 0.033	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.030

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

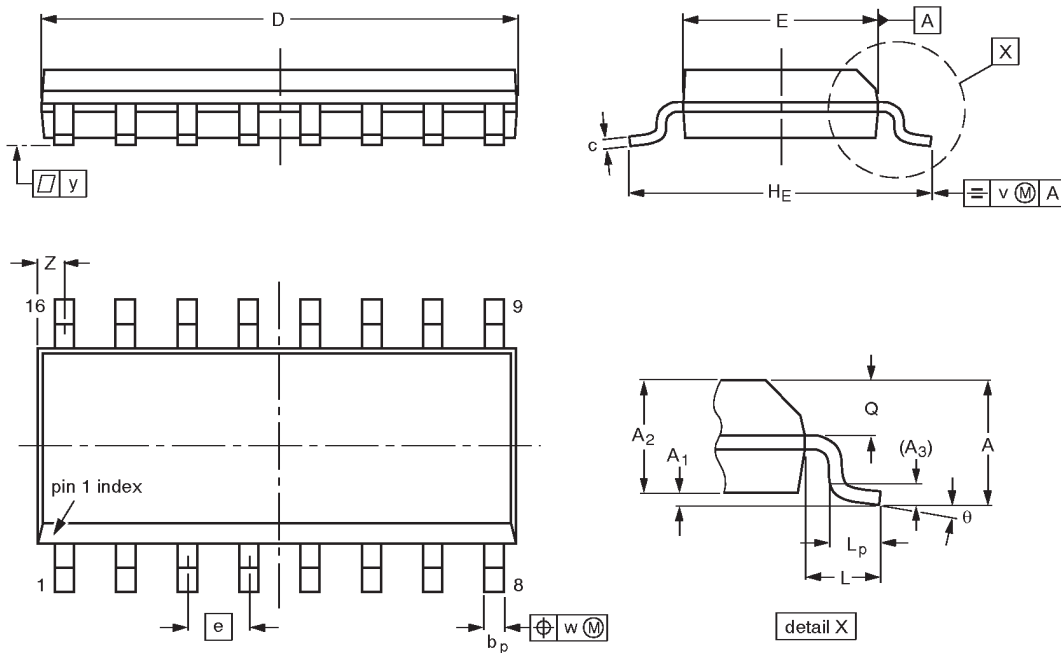
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT38-4						-92-11-17 95-01-14

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

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	z ⁽¹⁾	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.39 0.38	0.16 0.15	0.050	0.24 0.23	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

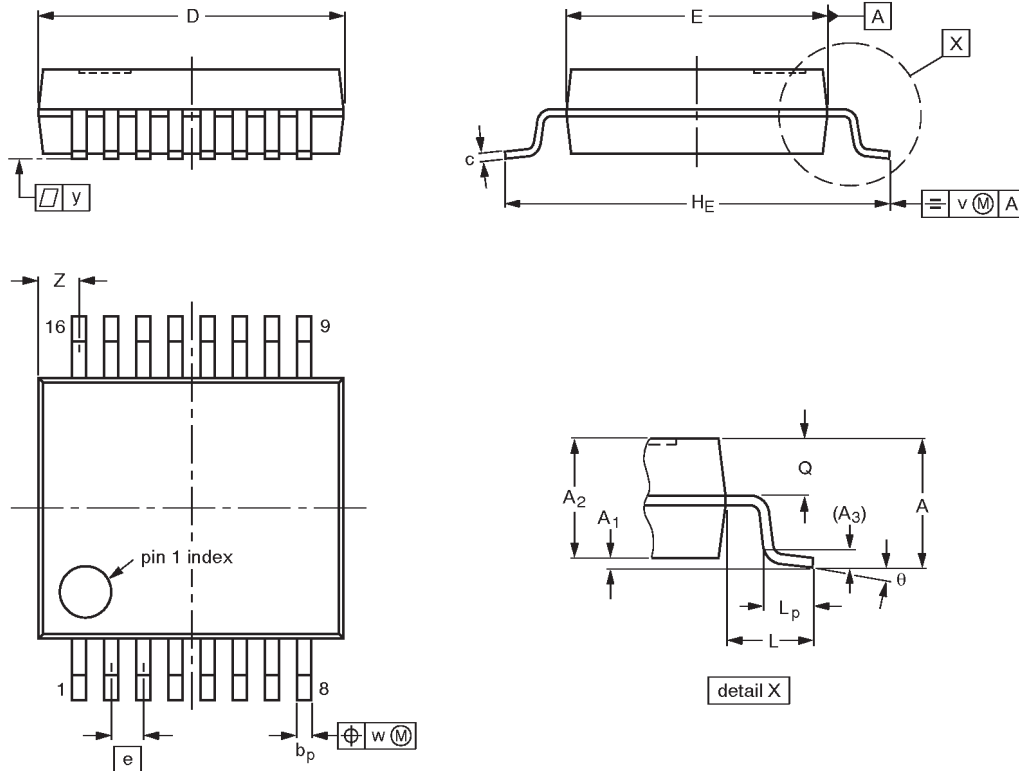
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	IEC	JEDEC	EIAJ			
SOT109-1	076E07S	MS-012AC				91-08-13 95-01-23

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

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SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.00 0.55	8° 0°

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

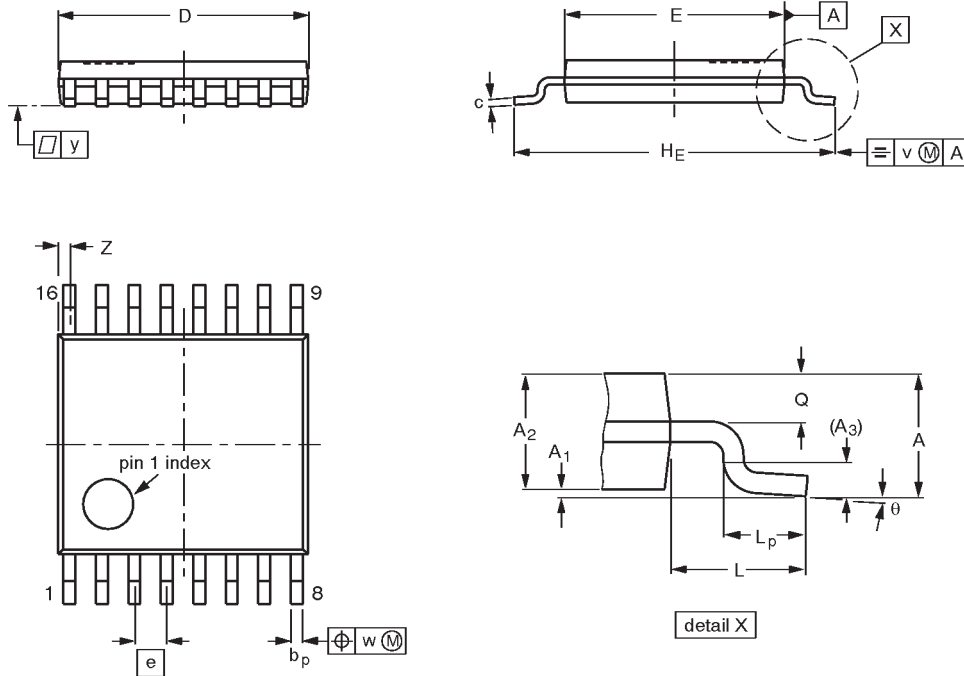
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT338-1		MO-150AC				94-01-14- 95-02-04

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

SOT403-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT403-1		MO-153				94-07-12 95-04-04

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DEFINITIONS

Data Sheet Identification	Product Status	Definition
<i>Objective Specification</i>	Formative or in Design	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
<i>Preliminary Specification</i>	Preproduction Product	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
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