

Dual J-K̄ Flip-Flop with Set and Reset Positive-Edge Trigger

March 1998 - Revised October 2003

Features

- Asynchronous Set and Reset
- Schmitt Trigger Clock Inputs
- Typical $f_{MAX} = 54\text{MHz}$ at $V_{CC} = 5\text{V}$, $C_L = 15\text{pF}$, $T_A = 25^\circ\text{C}$
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
 - 2V to 6V Operation
 - High Noise Immunity: $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC} at $V_{CC} = 5\text{V}$
- HCT Types
 - 4.5V to 5.5V Operation
 - Direct LSTTL Input Logic Compatibility, $V_{IL} = 0.8\text{V}$ (Max), $V_{IH} = 2\text{V}$ (Min)
 - CMOS Input Compatibility, $I_I \leq 1\mu\text{A}$ at V_{OL} , V_{OH}

Description

The 'HC109 and 'HCT109 are dual J-K̄ flip-flops with set and reset. The flip-flop changes state with the positive transition of Clock (1CP and 2CP).

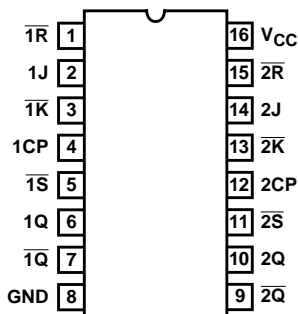
The flip-flop is set and reset by active-low \bar{S} and \bar{R} , respectively. A low on both the set and reset inputs simultaneously will force both Q and \bar{Q} outputs high. However, both set and reset going high simultaneously results in an unpredictable output condition.

Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD54HC109F3A	-55 to 125	16 Ld CERDIP
CD54HCT109F3A	-55 to 125	16 Ld CERDIP
CD74HC109E	-55 to 125	16 Ld PDIP
CD74HC109M	-55 to 125	16 Ld SOIC
CD74HC109MT	-55 to 125	16 Ld SOIC
CD74HC109M96	-55 to 125	16 Ld SOIC
CD74HCT109E	-55 to 125	16 Ld PDIP
CD74HCT109M	-55 to 125	16 Ld SOIC
CD74HCT109MT	-55 to 125	16 Ld SOIC
CD74HCT109M96	-55 to 125	16 Ld SOIC

Pinout

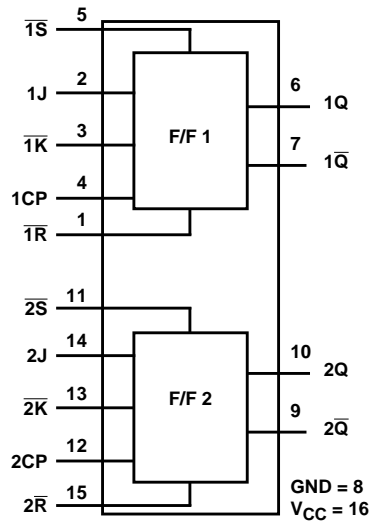
CD54HC109, CD54HCT109
(CERDIP)
CD74HC109, CD74HCT109
(PDIP, SOIC)
TOP VIEW



NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel. The suffix T denotes a small-quantity reel of 250.

CD54HC109, CD74HC109, CD54HCT109, CD74HCT109

Functional Diagram



TRUTH TABLE

INPUTS					OUTPUTS	
\bar{S}	\bar{R}	CP	J	\bar{K}	Q	\bar{Q}
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H (Note 1)	H (Note 1)
H	H	\uparrow	L	L	L	H
H	H	\uparrow	H	L	Toggle	
H	H	\uparrow	L	H	No Change	
H	H	\uparrow	H	H	H	L
H	H	L	X	X	No Change	

H= High Level (Steady State)

L= Low Level (Steady State)

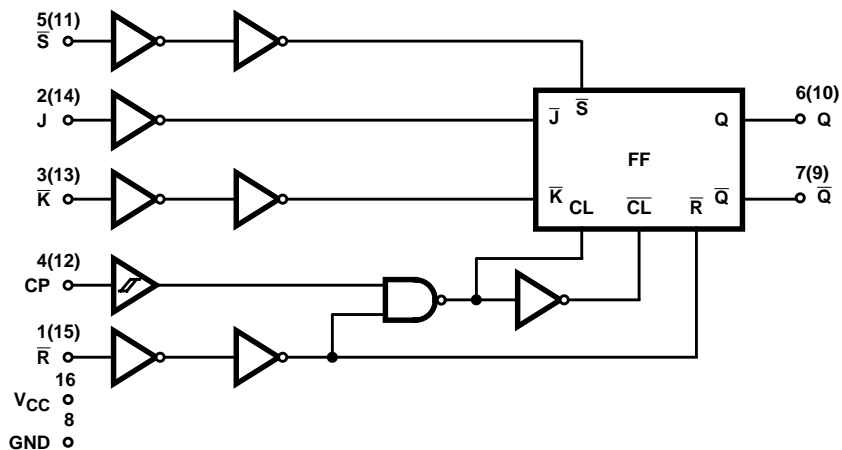
X= Don't Care

\uparrow = Low-to-High Transition

NOTE:

1. Unpredictable and unstable condition if both \bar{S} and \bar{R} go high simultaneously

Logic Diagram



CD54HC109, CD74HC109, CD54HCT109, CD74HCT109

Absolute Maximum Ratings

DC Supply Voltage, V_{CC}	-0.5V to 7V
DC Input Diode Current, I_{IK}	
For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$	$\pm 20mA$
DC Drain Current, per Output, I_O	
For $-0.5V < V_O < V_{CC} + 0.5V$	$\pm 25mA$
DC Output Diode Current, I_{OK}	
For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$	$\pm 20mA$
DC Output Source or Sink Current per Output Pin, I_O	
For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$	$\pm 25mA$
DC V_{CC} or Ground Current, I_{CC}	$\pm 50mA$

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} ($^{\circ}C/W$)
E (PDIP) Package	67
M (SOIC) Package	73
Maximum Junction Temperature (Hermetic Package or Die) . . .	175 $^{\circ}C$
Maximum Junction Temperature (Plastic Package)	150 $^{\circ}C$
Maximum Storage Temperature Range	-65 $^{\circ}C$ to 150 $^{\circ}C$
Maximum Lead Temperature (Soldering 10s)	300 $^{\circ}C$ (SOIC - Lead Tips Only)

Operating Conditions

Temperature Range, T_A	-55 $^{\circ}C$ to 125 $^{\circ}C$
Supply Voltage Range, V_{CC}	
HC Types	2V to 6V
HCT Types	4.5V to 5.5V
DC Input or Output Voltage, V_I, V_O	0V to V_{CC}
C_p Input Rise and Fall Time, t_r, t_f	
2V	1.0ms (Max)
4.5V	1.0ms (Max)
6V	1.0ms (Max)
Input Rise and Fall Time (All Inputs Except C_p), t_r, t_f	
2V	1000ns (Max)
4.5V	500ns (Max)
6V	400ns (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- The package thermal impedance is calculated in accordance with JESD 51-7

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25 $^{\circ}C$			-40 $^{\circ}C$ TO 85 $^{\circ}C$		-55 $^{\circ}C$ TO 125 $^{\circ}C$		UNITS	
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX		
HC TYPES													
High Level Input Voltage	V_{IH}	-	-	2	1.5	-	-	1.5	-	1.5	-	V	
				4.5	3.15	-	-	3.15	-	3.15	-	V	
				6	4.2	-	-	4.2	-	4.2	-	V	
Low Level Input Voltage	V_{IL}	-	-	2	-	-	0.5	-	0.5	-	0.5	V	
				4.5	-	-	1.35	-	1.35	-	1.35	V	
				6	-	-	1.8	-	1.8	-	1.8	V	
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	2	1.9	-	-	1.9	-	1.9	-	V	
				4.5	4.4	-	-	4.4	-	4.4	-	V	
				6	5.9	-	-	5.9	-	5.9	-	V	
High Level Output Voltage TTL Loads				-	-	-	-	-	-	-	-	V	
				-4	4.5	3.96	-	-	3.84	-	3.7	-	V
				-5.2	6	5.48	-	-	5.34	-	5.2	-	V

CD54HC109, CD74HC109, CD54HCT109, CD74HCT109

DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS	
		V _I (V)	I _O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX		
Low Level Output Voltage Voltage CMOS Loads	V _{OL}	V _{IH} or V _{IL}	0.02	2	-	-	0.1	-	0.1	-	0.1	V	
				4.5	-	-	0.1	-	0.1	-	0.1	V	
				6	-	-	0.1	-	0.1	-	0.1	V	
Low Level Output Voltage Voltage TTL Loads	V _{OL}	V _{IH} or V _{IL}	-	-	-	-	-	-	-	-	-	V	
				4	4.5	-	-	0.26	-	0.33	-	0.4	V
				5.2	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I _I	V _{CC} or GND	-	6	-	-	±0.1	-	±1	-	±1	μA	
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	6	-	-	4	-	40	-	80	μA	
HCT TYPES													
High Level Input Voltage	V _{IH}	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V	
Low Level Input Voltage	V _{IL}	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V	
High Level Output Voltage Voltage CMOS Loads	V _{OH}	V _{IH} or V _{IL}	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V	
			-4	4.5	3.98	-	-	3.84	-	3.7	-	V	
Low Level Output Voltage Voltage CMOS Loads	V _{OL}	V _{IH} or V _{IL}	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V	
			4	4.5	-	-	0.26	-	0.33	-	0.4	V	
Input Leakage Current	I _I	V _{CC} and GND	-	5.5	-	-	±0.1	-	±1	-	±1	μA	
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	5.5	-	-	4	-	40	-	80	μA	
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI _{CC} (Note 3)	V _{CC} - 2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA	

NOTE:

- For dual-supply systems theoretical worst case (V_I = 2.4V, V_{CC} = 5.5V) specification is 1.8mA.

HCT Input Loading Table

INPUT	UNIT LOADS
All	0.3

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Specifications table, e.g., 360μA max at 25°C.

CD54HC109, CD74HC109, CD54HCT109, CD74HCT109

Prerequisite For Switching Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Setup Time J, \bar{K} , to CP	t _{SU}	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Hold Time J, \bar{K} , to CP	t _H	-	2	5	-	-	5	-	5	-	ns
			4.5	5	-	-	5	-	5	-	ns
			6	5	-	-	5	-	5	-	ns
Removal Time \bar{R} , \bar{S} , to CP	t _{REM}	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Pulse Width CP, \bar{R} , \bar{S}	t _W	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
CP Frequency	f _{MAX}	-	2	6	-	-	5	-	4	-	MHz
			4.5	30	-	-	25	-	20	-	MHz
			6	35	-	-	29	-	23	-	MHz
HCT TYPES											
Setup Time J, \bar{K} to CP	t _{SU}	-	4.5	18	-	-	23	-	27	-	ns
Hold Time J, \bar{K} to CP	t _H	-	4.5	3	-	-	3	-	3	-	ns
Removal Time \bar{R} , \bar{S} , to CP	t _{REM}	-	4.5	18	-	-	23	-	27	-	ns
Pulse Width CP, \bar{R} , \bar{S}	t _W	-	4.5	18	-	-	23	-	27	-	ns
CP Frequency	f _{MAX}	-	4.5	27	-	-	22	-	18	-	MHz

Switching Specifications Input t_r, t_f = 6ns

PARAMETER	SYMBOL	TEST CONDITIONS	V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Propagation Delay, CP → Q, \bar{Q}	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	175	-	220	-	265	ns
		C _L = 50pF	4.5	-	-	35	-	44	-	53	ns
		C _L = 15pF	5	-	14	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	30	-	37	-	45	ns
Propagation Delay, \bar{S} → Q	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	120	-	150	-	180	ns
		C _L = 50pF	4.5	-	-	24	-	30	-	36	ns
		C _L = 15pF	5	-	9	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	20	-	26	-	31	ns
Propagation Delay, \bar{S} → \bar{Q}	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	155	-	195	-	235	ns
		C _L = 50pF	4.5	-	-	31	-	39	-	47	ns
		C _L = 15pF	5	-	13	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	26	-	33	-	40	ns

CD54HC109, CD74HC109, CD54HCT109, CD74HCT109

Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

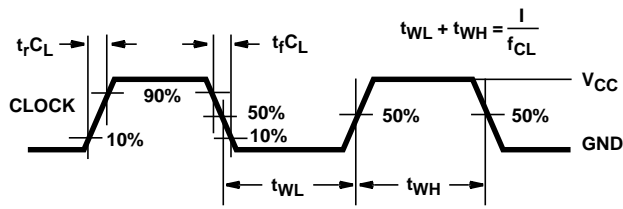
PARAMETER	SYMBOL	TEST CONDITIONS	V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Propagation Delay, R → Q	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	185	-	230	-	280	ns
		C _L = 50pF	4.5	-	-	37	-	46	-	56	ns
		C _L = 15pF	5	-	15	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	31	-	39	-	48	ns
Propagation Delay, R̄ → Q̄	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	170	-	215	-	255	ns
		C _L = 50pF	4.5	-	-	34	-	43	-	51	ns
		C _L = 15pF	5	-	14	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	29	-	37	-	43	ns
Transition Time	t _{TLH} , t _{THL}	C _L = 50pF	2	-	-	75	-	95	-	110	ns
		C _L = 50pF	4.5	-	-	15	-	19	-	22	ns
		C _L = 50pF	6	-	-	13	-	16	-	19	ns
Input Capacitance	C _I	-	-	-	10	-	10	-	10	pF	
CP Frequency	f _{MAX}	C _L = 15pF	5	-	60	-	-	-	-	MHz	
Power Dissipation Capacitance (Notes 4, 5)	C _{PD}	-	5	-	30	-	-	-	-	pF	
HCT TYPES											
Propagation Delay, CP → Q, Q̄	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	40	-	50	-	60	ns
		C _L = 15pF	5	-	17	-	-	-	-	-	ns
Propagation Delay, S → Q	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	30	-	38	-	45	ns
		C _L = 15pF	5	-	12	-	-	-	-	-	ns
Propagation Delay, S̄ → Q̄	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	45	-	56	-	68	ns
		C _L = 15pF	5	-	19	-	-	-	-	-	ns
Propagation Delay, R̄ → Q̄	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	45	-	56	-	68	ns
		C _L = 15pF	5	-	19	-	-	-	-	-	ns
Propagation Delay, R̄ → Q̄	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	37	-	46	-	56	ns
		C _L = 15pF	5	-	15	-	-	-	-	-	ns
Transition Time (Figure 5)	t _{TLH} , t _{THL}	C _L = 50pF	4.5	-	-	15	-	19	-	22	ns
Input Capacitance	C _I	-	-	-	10	-	10	-	10	pF	
CP Frequency	f _{MAX}	C _L = 15pF	5	-	54	-	-	-	-	MHz	
Power Dissipation Capacitance (Notes 4, 5)	C _{PD}	-	5	-	33	-	-	-	-	pF	

NOTES:

- C_{PD} is used to determine the dynamic power consumption, per flip-flop.
- $P_D = C_{PD} V_{CC}^2 f_i + \sum C_L f_o$ where f_i = input frequency, f_o = output frequency, C_L = output load capacitance, V_{CC} = supply voltage.

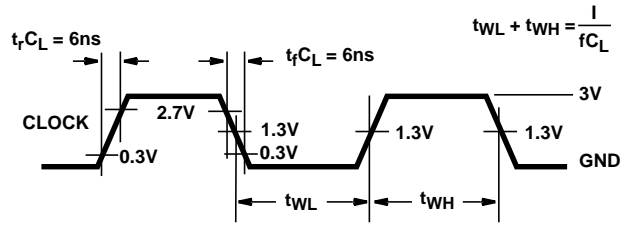
CD54HC109, CD74HC109, CD54HCT109, CD74HCT109

Test Circuits and Waveforms



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX} , input duty cycle = 50%.

FIGURE 7. HC CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX} , input duty cycle = 50%.

FIGURE 8. HCT CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

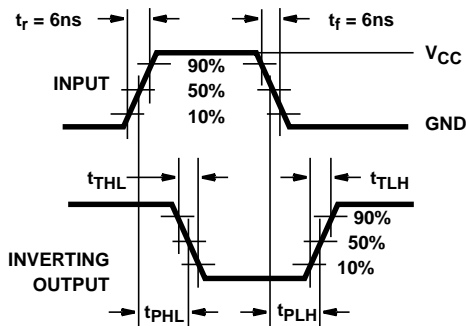


FIGURE 9. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

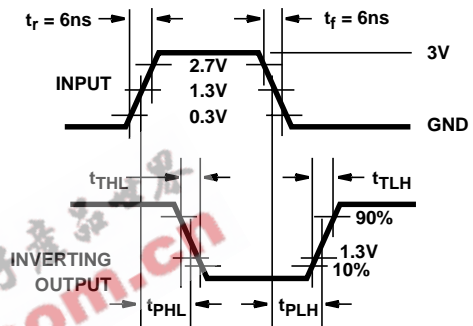


FIGURE 10. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

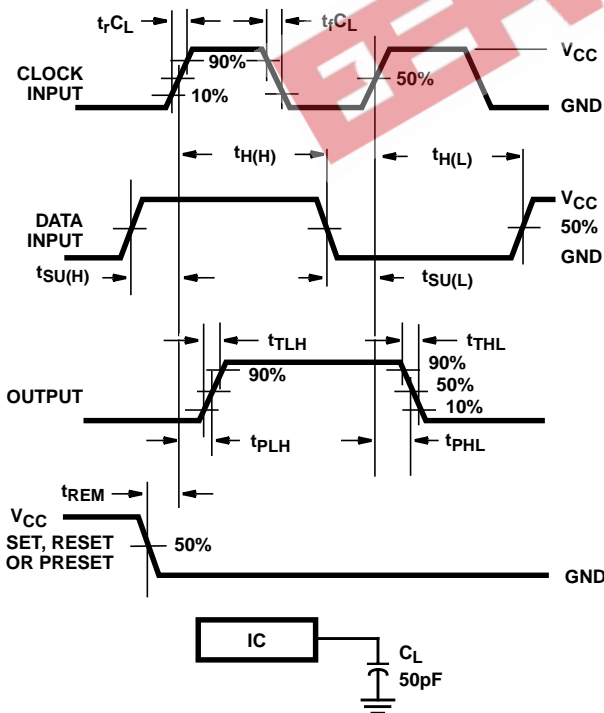


FIGURE 11. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

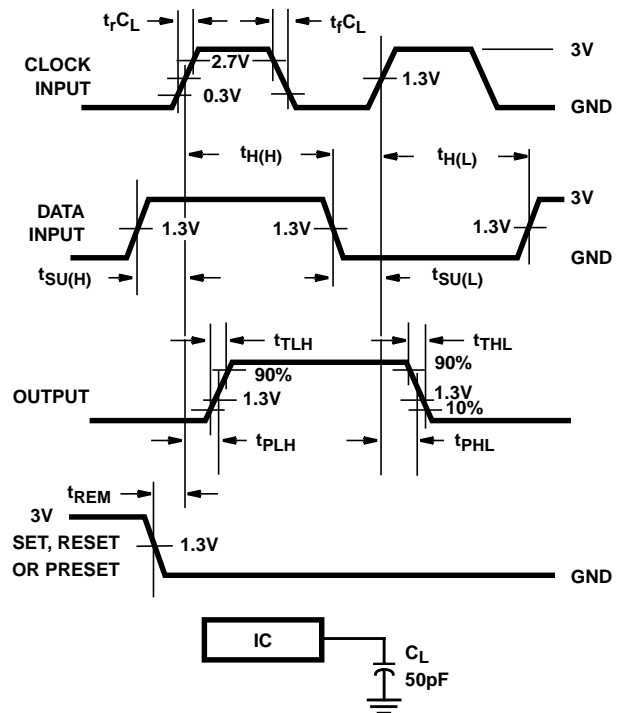


FIGURE 12. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
5962-9070101MEA	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD54HC109F3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD54HCT109F3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD74HC109E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC109M	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HC109M96	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HC109MT	ACTIVE	SOIC	D	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HCT109E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HCT109M	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HCT109M96	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HCT109MT	ACTIVE	SOIC	D	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

None: Not yet available Lead (Pb-Free).

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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J (R-GDIP-T**)
14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

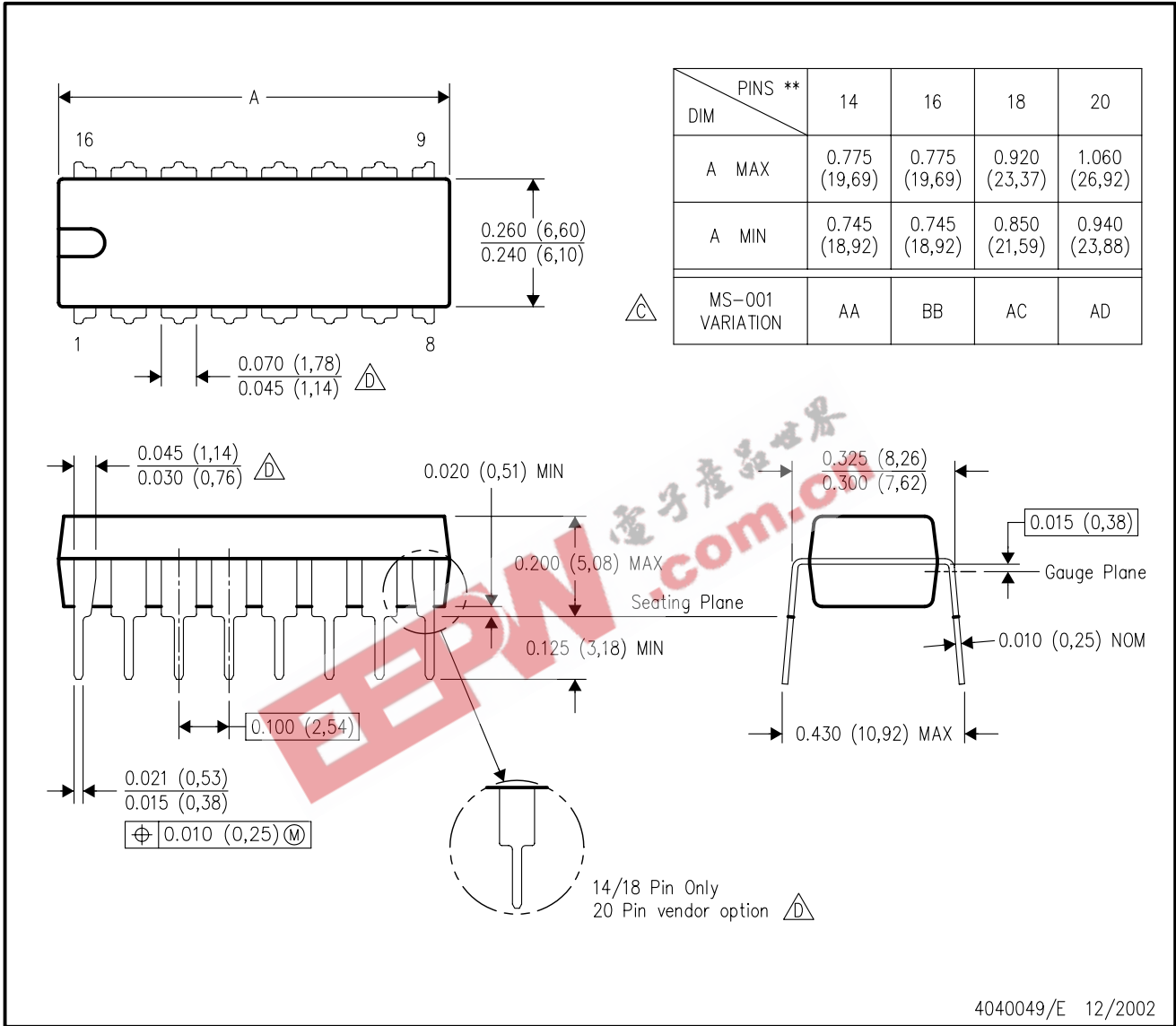
- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package is hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

MECHANICAL DATA

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

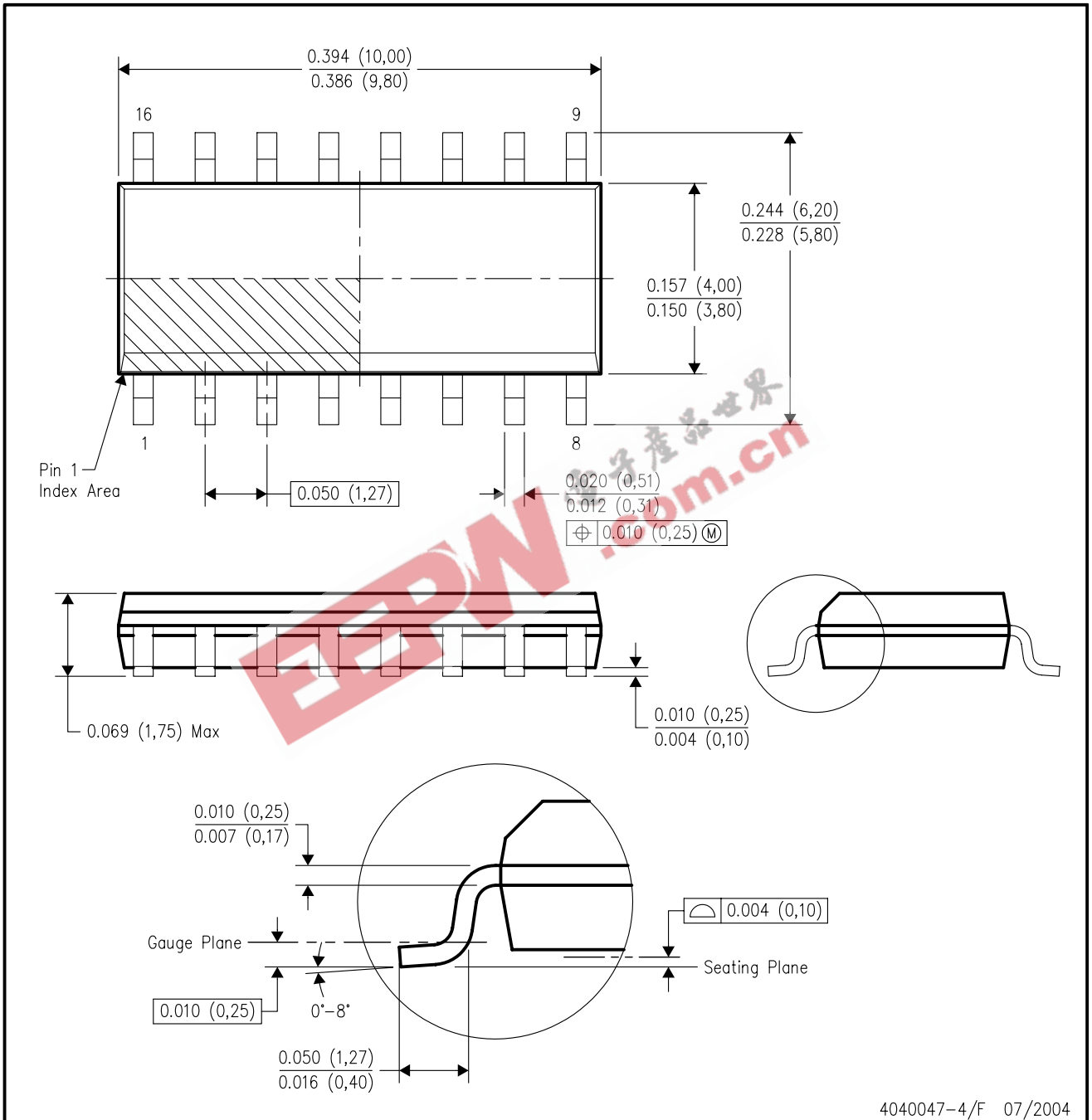


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

MECHANICAL DATA

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-4/F 07/2004

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