CD54HC112, CD74HC112, CD54HCT112, CD74HCT112

Dual J-K Flip-Flop with Set and Reset Negative-Edge Trigger

Data sheet acquired from Harris Semiconductor
SCHS141H

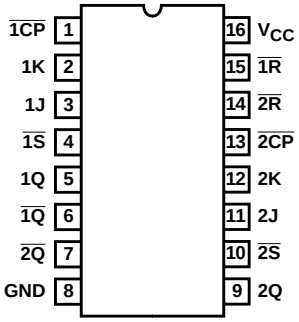
March 1998 - Revised October 2003

Features

- Hysteresis on Clock Inputs for Improved Noise Immunity and Increased Input Rise and Fall Times
- Asynchronous Set and Reset
- Complementary Outputs
- Buffered Inputs
- Typical f_{MAX} = 60MHz at V_{CC} = 5V, C_L = 15pF, T_A = 25°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} = 5V
- HCT Types
  - 4.5V to 5.5V Operation
  - Direct LSTTL Input Logic Compatibility, V_{IL}= 0.8V (Max), V_{IH} = 2V (Min)
  - CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL}, V_{OH}

Pinout

CD54HC112, CD54HCT112 (CERDIP)
CD74HC112 (PDIP, SOIC, SOP, TSSOP)
CD74HCT112 (PDIP)
TOP VIEW



Description

The 'HC112 and 'HCT112 utilize silicon-gate CMOS technology to achieve operating speeds equivalent to LSTTL parts. They exhibit the low power consumption of standard CMOS integrated circuits, together with the ability to drive 10 LSTTL loads.

These flip-flops have independent J, K, Set, Reset, and Clock inputs and Q and $\overline{Q}$ outputs. They change state on the negative-going transition of the clock pulse. Set and Reset are accomplished asynchronously by low-level inputs.

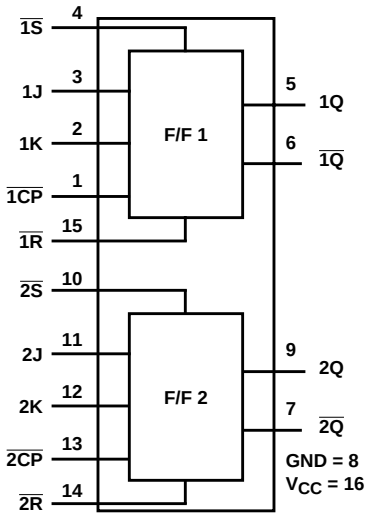
The HCT logic family is functionally as well as pin-compatible with the standard LS logic family.

Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD54HC112F3A	-55 to 125	16 Ld CERDIP
CD54HCT112F3A	-55 to 125	16 Ld CERDIP
CD74HC112E	-55 to 125	16 Ld PDIP
CD74HC112MT	-55 to 125	16 Ld SOIC
CD74HC112M96	-55 to 125	16 Ld SOIC
CD74HC112NSR	-55 to 125	16 Ld SOP
CD74HC112PW	-55 to 125	16 Ld TSSOP
CD74HC112PWR	-55 to 125	16 Ld TSSOP
CD74HC112PWT	-55 to 125	16 Ld TSSOP
CD74HCT112E	-55 to 125	16 Ld PDIP

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

Functional Diagram



TRUTH TABLE

INPUTS					OUTPUTS	
$\overline{S}$	$\overline{R}$	$\overline{CP}$	J	K	Q	$\overline{Q}$
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	↓	L	L	No Change	
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	Toggle	
H	H	H	X	X	No Change	

H= High Level (Steady State)
L= Low Level (Steady State)
X= Don't Care
↓= High-to-Low Transition
NOTE:

1. Output states unpredictable if both $\overline{S}$ and $\overline{R}$ go High simultaneously after both being low at the same time.

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 . . . . . ±20mA
DC Drain Current, per Output, I_O
For -0.5V < V_O < V_{CC} + 0.5V . . . . . ±25mA
DC Output Diode Current, I_{OK}
For V_O < -0.5V or V_O > V_{CC} + 0.5V . . . . . ±20mA
DC Output Source or Sink Current per Output Pin, I_O
For V_O > -0.5V or V_O < V_{CC} + 0.5V . . . . . ±25mA
DC V_{CC} or Ground Current, I_{CC} . . . . . ±50mA

Operating Conditions

Temperature Range, T_A . . . . . -55°C to 125°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}
Input Rise and Fall Time, t_r, t_f
2V . . . . . 1.0ms (Max)
4.5V. . . . . 1.0ms (Max)
6V . . . . . 1.0ms (Max)

Thermal Information

Package Thermal Impedance, θ_{JA} (see Note 2):
E (PDIP) Package . . . . . 67°C/W
NS (SOP) Package . . . . . 64°C/W
D (SOIC) Package . . . . . 73°C/W
PW (TSSOP) Package . . . . . 108°C/W
Maximum Junction Temperature (Hermetic Package or Die) . 175°C
Maximum Junction Temperature (Plastic Package) . . . . . 150°C
Maximum Storage Temperature Range . . . . . -65°C to 150°C
Maximum Lead Temperature (Soldering 10s) . . . . . 300°C

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:

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

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS			25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V_I (V)	I_O (mA)	V_{CC} (V)	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	3.98	-	-	3.84	-	3.7	-	V
			-5.2	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output 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 TTL Loads			-	-	-	-	-	-	-	-	-	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

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	
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 CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High Level Output Voltage TTL Loads			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads			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:

3. 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
$\overline{1S}$, $\overline{2S}$	0.5
1K, 2K	0.6
$\overline{1R}$, $\overline{2R}$	0.65
1J, 2J, $\overline{1CP}$, $\overline{2CP}$	1

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

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											
Pulse Width $\overline{CP}$	t_W	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns

Prerequisite For Switching Specifications (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	
Pulse Width $\overline{R}$, $\overline{S}$	t_W	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Setup Time J, K, to $\overline{CP}$	t_{SU}	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Hold Time J, K, to $\overline{CP}$	t_H	-	2	0	-	-	0	-	0	-	ns
			4.5	0	-	-	0	-	0	-	ns
			6	0	-	-	0	-	0	-	ns
Removal Time $\overline{R}$ to $\overline{CP}$, $\overline{S}$ to $\overline{CP}$	t_{REM}	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
$\overline{CP}$ Frequency	f_{MAX}	-	2	6	-	-	5	-	4	-	MHz
			4.5	30	-	-	25	-	20	-	MHz
			6	35	-	-	29	-	23	-	MHz
HCT TYPES											
Pulse Width $\overline{CP}$	t_{SU}	-	4.5	16	-	-	20	-	24	-	ns
Pulse Width $\overline{R}$, $\overline{S}$	t_W	-	4.5	18	-	-	23	-	27	-	ns
Setup Time J, K, to $\overline{CP}$	t_H	-	4.5	16	-	-	20	-	24	-	ns
Hold Time J, K, to $\overline{CP}$	t_{REM}	-	4.5	3	-	-	3	-	3	-	ns
Removal Time $\overline{R}$ to $\overline{CP}$, $\overline{S}$ to $\overline{CP}$	t_W	-	4.5	20	-	-	25	-	30	-	ns
$\overline{CP}$ Frequency	f_{MAX}	-	4.5	30	-	-	25	-	20	-	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, $\overline{CP}$ to Q, $\overline{Q}$	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, $\overline{S}$ to Q, $\overline{Q}$	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
Propagation Delay, $\overline{R}$ to Q, $\overline{Q}$	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	180	-	225	-	270	ns
		C_L = 50pF	4.5	-	-	36	-	45	-	54	ns
		C_L = 15pF	5	-	15	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	31	-	38	-	46	ns

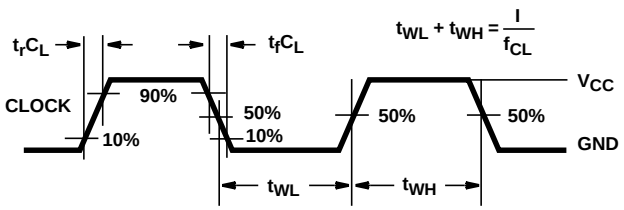
Switching Specifications Input t_r, t_f = 6ns (Continued)

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	
Output 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	-	12	-	-	-	-	-	pF
HCT TYPES											
Propagation Delay, $\overline{CP}$ to Q, $\overline{Q}$	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	35	-	44	-	53	ns
		C_L = 15pF	5	-	14	-	-	-	-	-	ns
Propagation Delay, $\overline{S}$ to Q, $\overline{Q}$	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	32	-	40	-	48	ns
		C_L = 15pF	5	-	13	-	-	-	-	-	ns
Propagation Delay, $\overline{R}$ to Q, $\overline{Q}$	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	37	-	46	-	56	ns
		C_L = 15pF	5	-	14	-	-	-	-	-	ns
Output Transition Time	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}	CL = 15pF	5	-	60	-	-	-	-	-	MHz
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	-	5	-	20	-	-	-	-	-	pF

NOTES:

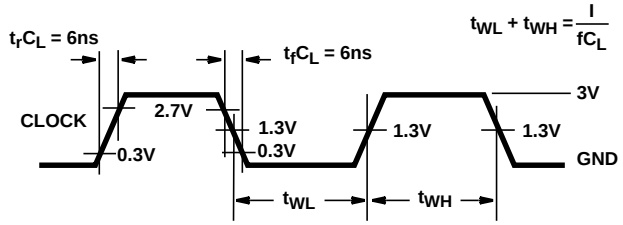
4. C_{PD} is used to determine the dynamic power consumption, per flip-flop.
5. $P_D = C_{PD} V_{CC}^2 f_i + \Sigma C_L f_o$ where f_i = input frequency, f_o = output frequency, C_L = output load capacitance, V_{CC} = supply voltage.

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 1. 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 2. HCT CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

Test Circuits and Waveforms (Continued)

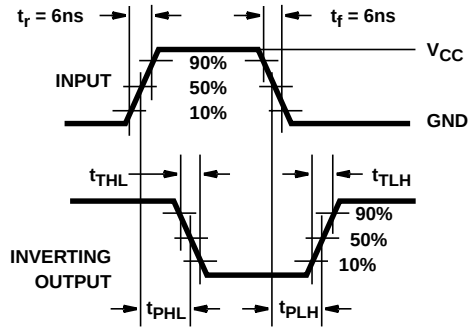


FIGURE 3. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

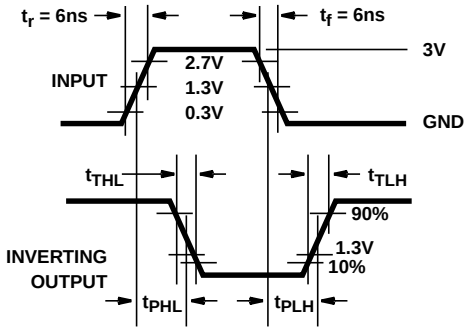


FIGURE 4. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

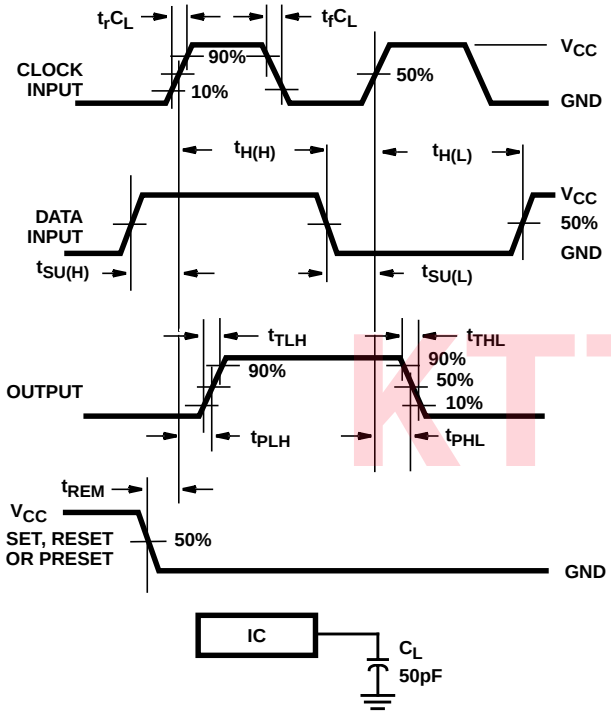


FIGURE 5. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

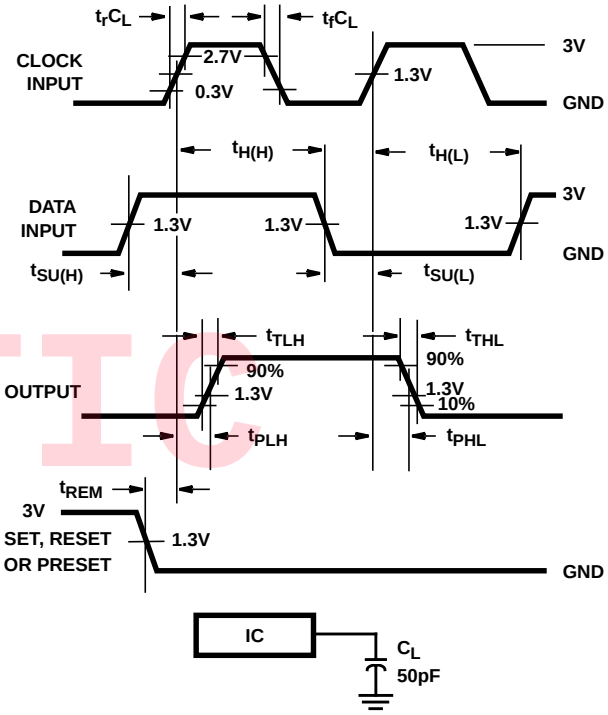
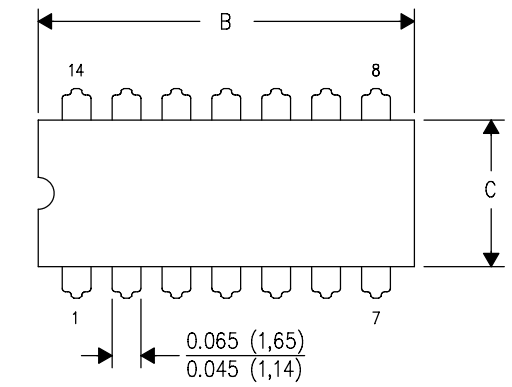


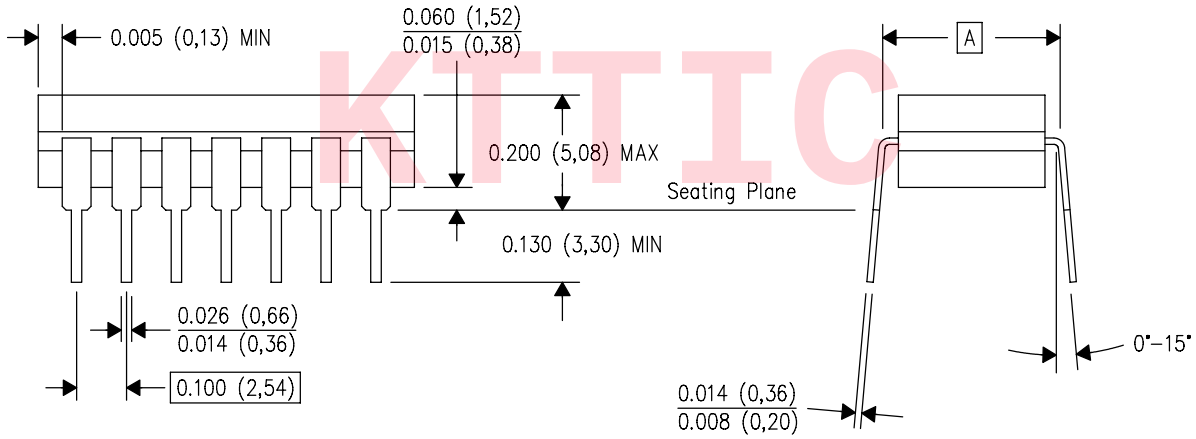
FIGURE 6. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

J (R–GDIP–T**) CERAMIC DUAL IN–LINE PACKAGE

14 LEADS SHOWN



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)

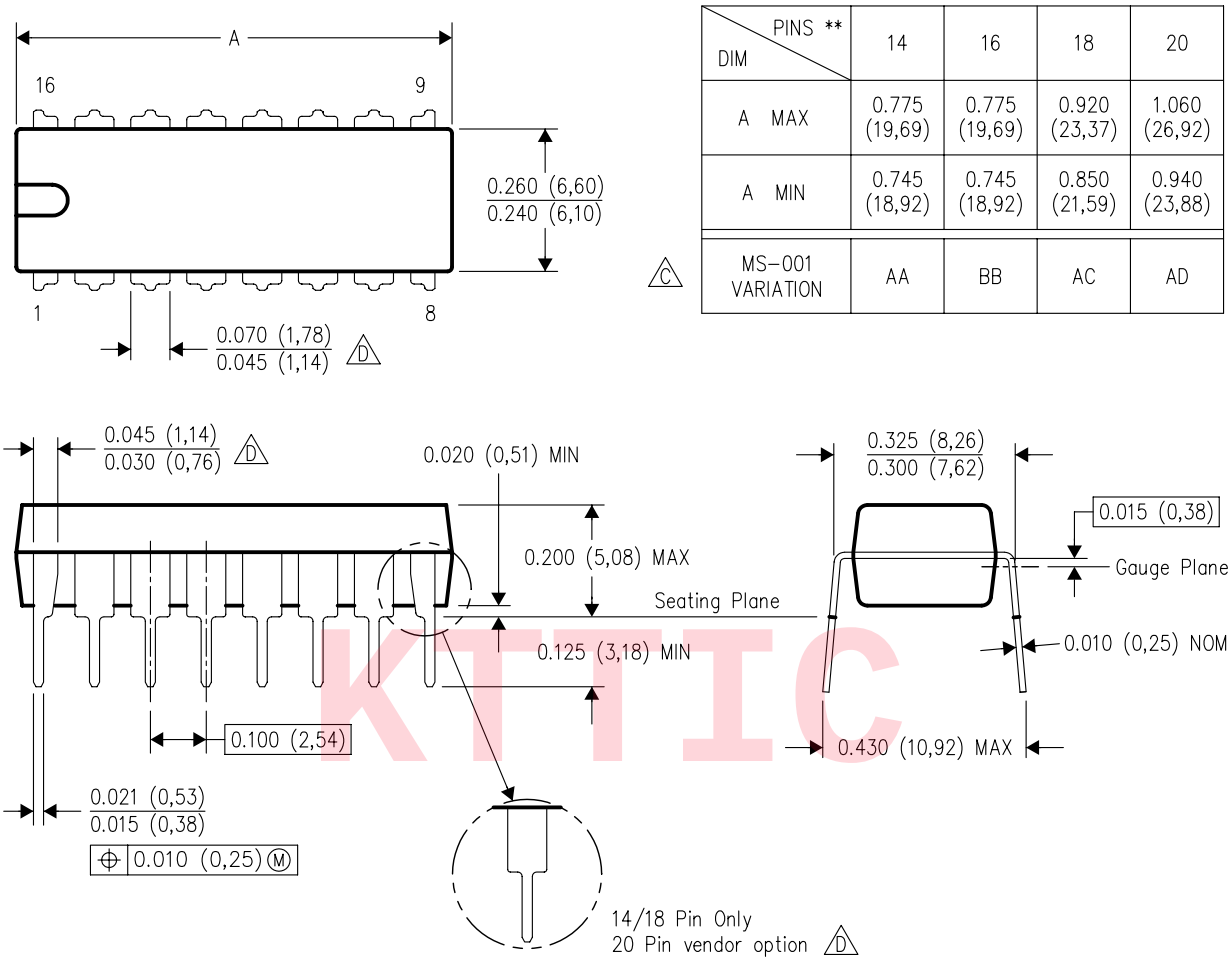


4040083/F 03/03

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

N (R–PDIP–T**) PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN

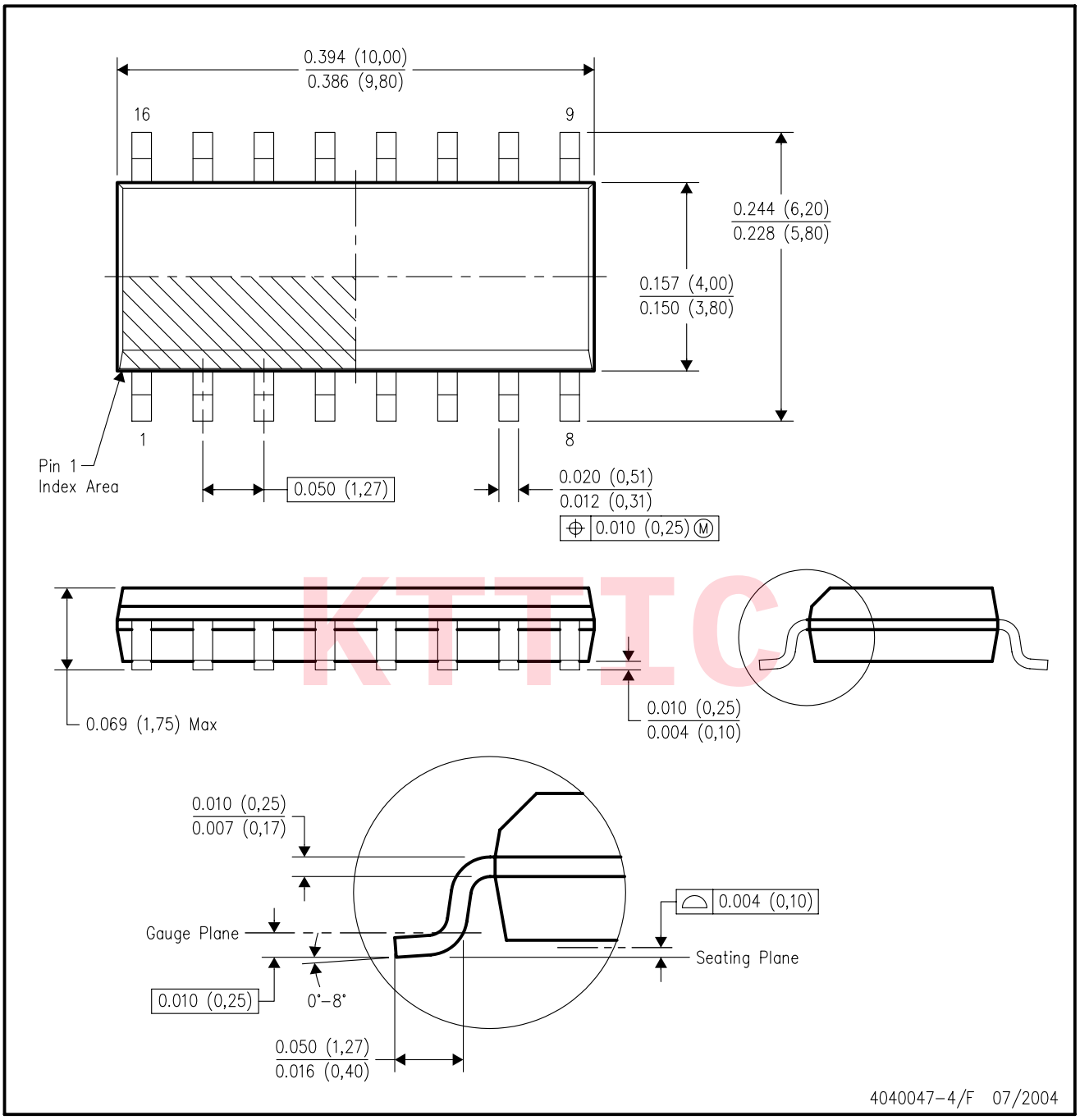


DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION	AA	BB	AC	AD

4040049/E 12/2002

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

D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE

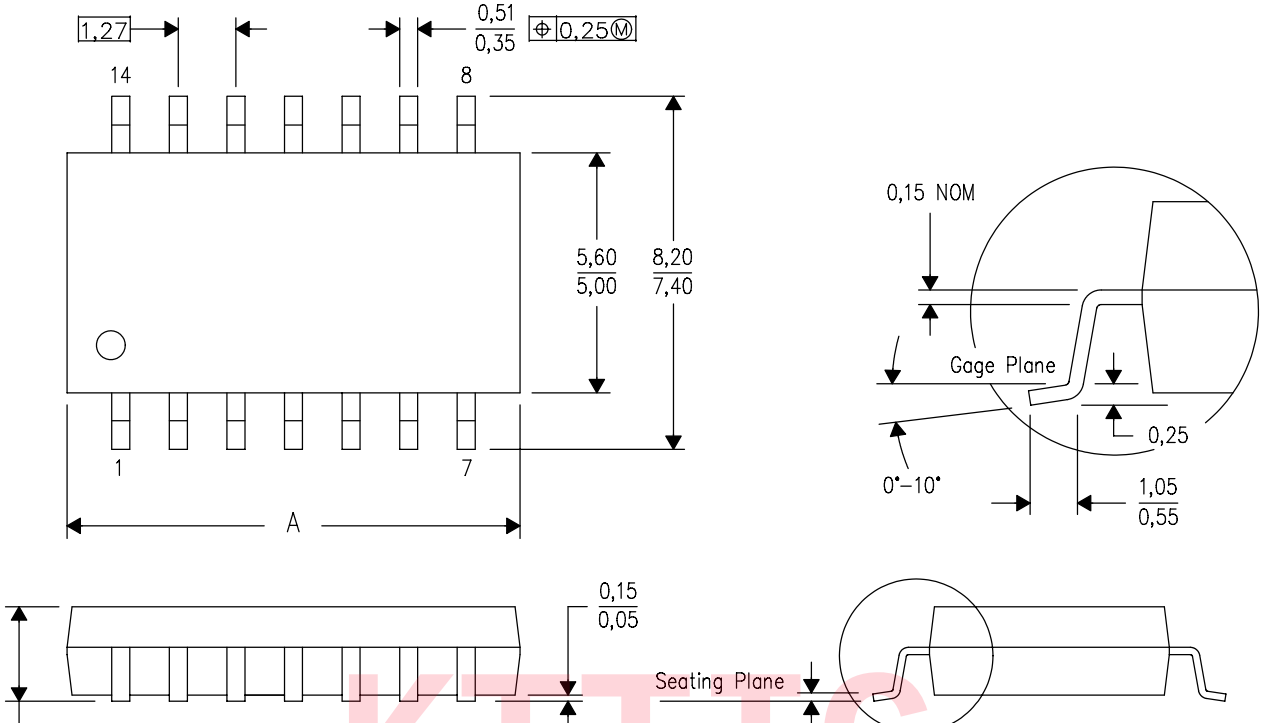


NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN



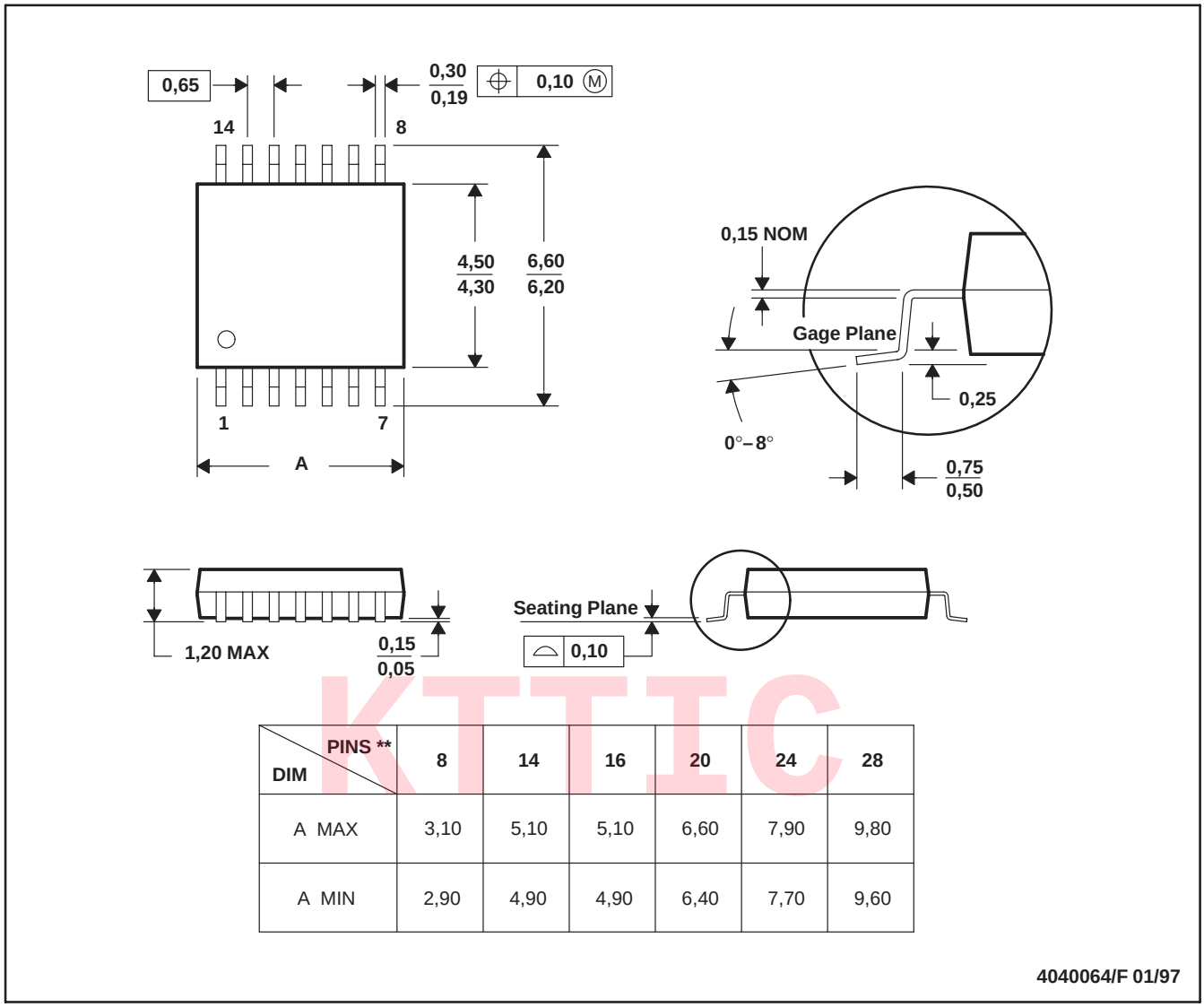
DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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