

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

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 $f_{MAX} = 60\text{MHz}$ 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 '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 \bar{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.

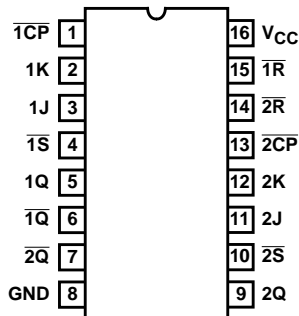
Ordering Information

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

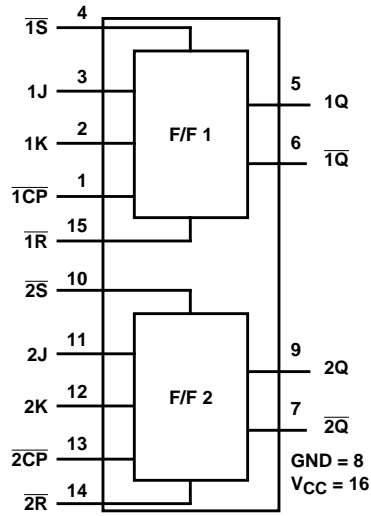
NOTE: When ordering, use the entire part number. The suffixes 96 and R denote tape and reel. The suffix T denotes a small-quantity reel of 250.

Pinout

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



Functional Diagram



TRUTH TABLE

INPUTS					OUTPUTS	
\bar{S}	\bar{R}	\bar{CP}	J	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	↓	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 \bar{S} and \bar{R} go High simultaneously after both being low at the same time.

CD54HC112, CD74HC112, CD54HCT112, CD74HCT112

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

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

Operating Conditions

Temperature Range, T_A	-55°C to 125°C
Supply Voltage Range, V_{CC}	
HC Types2V 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)

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°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		
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_{OH}	V_{IH} or V_{IL}	-	-	-	-	-	-	-	-	-	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_{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	

CD54HC112, CD74HC112, CD54HCT112, CD74HCT112

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
1S, 2S	0.5
1K, 2K	0.6
1R, 2R	0.65
1J, 2J, 1CP, 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

CD54HC112, CD74HC112, CD54HCT112, CD74HCT112

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 \bar{R} , \bar{S}	t_W	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Setup Time J, K, to \bar{CP}	t_{SU}	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Hold Time J, K, to \bar{CP}	t_H	-	2	0	-	-	0	-	0	-	ns
			4.5	0	-	-	0	-	0	-	ns
			6	0	-	-	0	-	0	-	ns
Removal Time \bar{R} to \bar{CP} , \bar{S} to \bar{CP}	t_{REM}	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
\bar{CP} Frequency	f_{MAX}	-	2	6	-	-	5	-	4	-	MHz
			4.5	30	-	-	25	-	20	-	MHz
			6	35	-	-	29	-	23	-	MHz

HCT TYPES

Pulse Width \bar{CP}	t_{SU}	-	4.5	16	-	-	20	-	24	-	ns
Pulse Width \bar{R} , \bar{S}	t_W	-	4.5	18	-	-	23	-	27	-	ns
Setup Time J, K, to \bar{CP}	t_H	-	4.5	16	-	-	20	-	24	-	ns
Hold Time J, K, to \bar{CP}	t_{REM}	-	4.5	3	-	-	3	-	3	-	ns
Removal Time \bar{R} to \bar{CP} , \bar{S} to \bar{CP}	t_W	-	4.5	20	-	-	25	-	30	-	ns
\bar{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, \bar{CP} to 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} to Q, 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, \bar{R} to Q, \bar{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

CD54HC112, CD74HC112, CD54HCT112, CD74HCT112

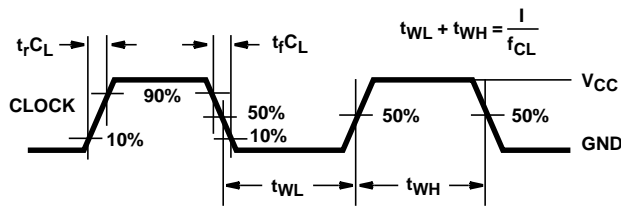
Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

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	
Output Transition Time	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	2	-	-	75	-	95	-	110	ns
		$C_L = 50\text{pF}$	4.5	-	-	15	-	19	-	22	ns
		$C_L = 50\text{pF}$	6	-	-	13	-	16	-	19	ns
Input Capacitance	C_I	-	-	-	10	-	10	-	10	pF	
CP Frequency	f_{MAX}	$C_L = 15\text{pF}$	5	-	60	-	-	-	-	MHz	
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	-	5	-	12	-	-	-	-	pF	
HCT TYPES											
Propagation Delay, CP to Q, \bar{Q}	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	35	-	44	-	53	ns
		$C_L = 15\text{pF}$	5	-	14	-	-	-	-	-	ns
Propagation Delay, \bar{S} to Q, \bar{Q}	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	32	-	40	-	48	ns
		$C_L = 15\text{pF}$	5	-	13	-	-	-	-	-	ns
Propagation Delay, \bar{R} to Q, \bar{Q}	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	37	-	46	-	56	ns
		$C_L = 15\text{pF}$	5	-	14	-	-	-	-	-	ns
Output Transition Time	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	-	15	-	19	-	22	ns
Input Capacitance	C_I	-	-	-	10	-	10	-	10	pF	
CP Frequency	f_{MAX}	$C_L = 15\text{pF}$	5	-	60	-	-	-	-	MHz	
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	-	5	-	20	-	-	-	-	pF	

NOTES:

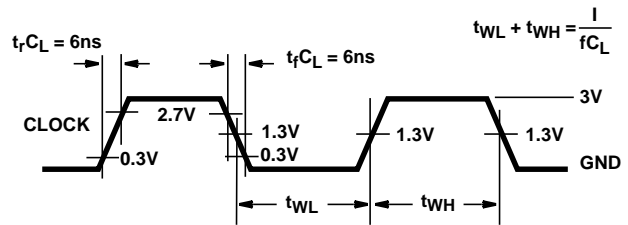
- C_{PD} is used to determine the dynamic power consumption, per flip-flop.
- $P_D = C_{PD} V_{CC}^2 f_i + \sum C_L f_o$ where f_i = input frequency, f_o = output frequency, C_L = output load capacitance, V_{CC} = supply voltage.

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)

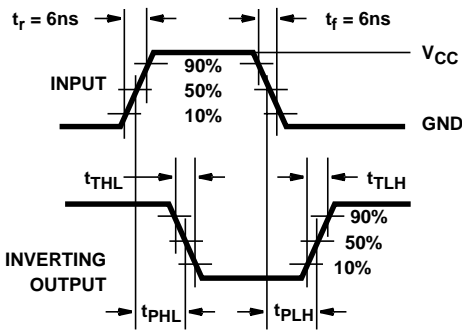


FIGURE 3. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

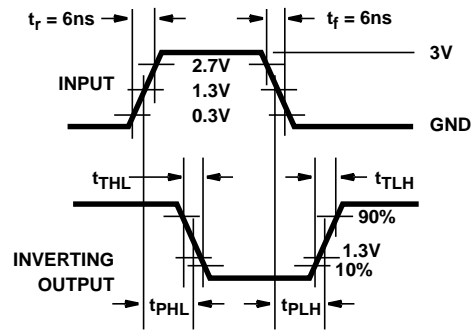


FIGURE 4. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

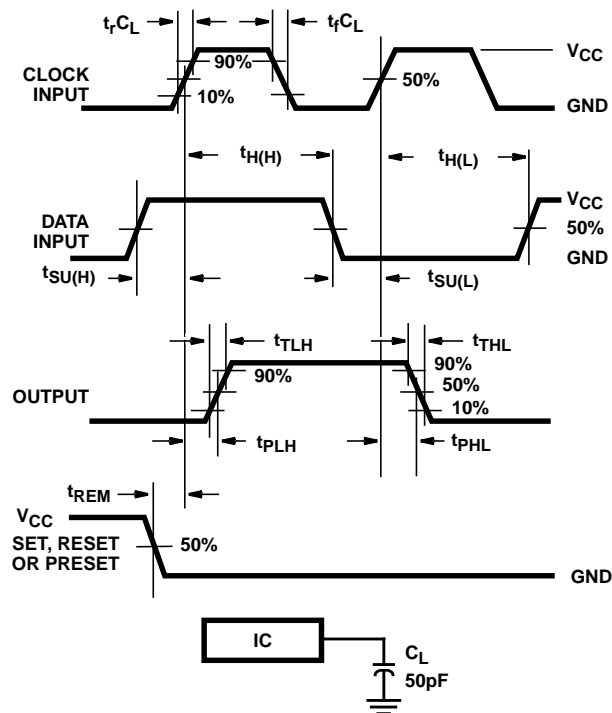


FIGURE 5. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

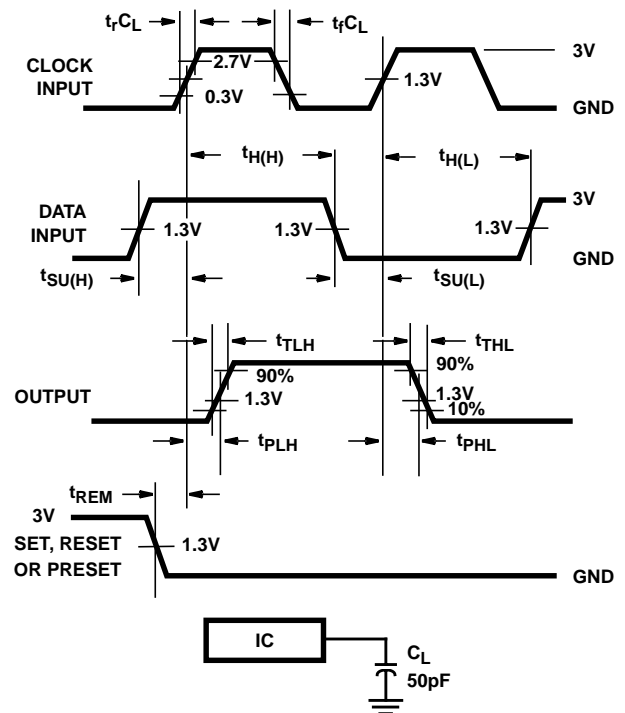


FIGURE 6. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
5962-8970201EA	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD54HC112F3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD54HCT112F3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD74HC112E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC112M96	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HC112MT	ACTIVE	SOIC	D	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HC112NSR	ACTIVE	SO	NS	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD74HC112PW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD74HC112PWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD74HC112PWT	ACTIVE	TSSOP	PW	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD74HCT112E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

⁽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.

OBSELETE: 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)



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- 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.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

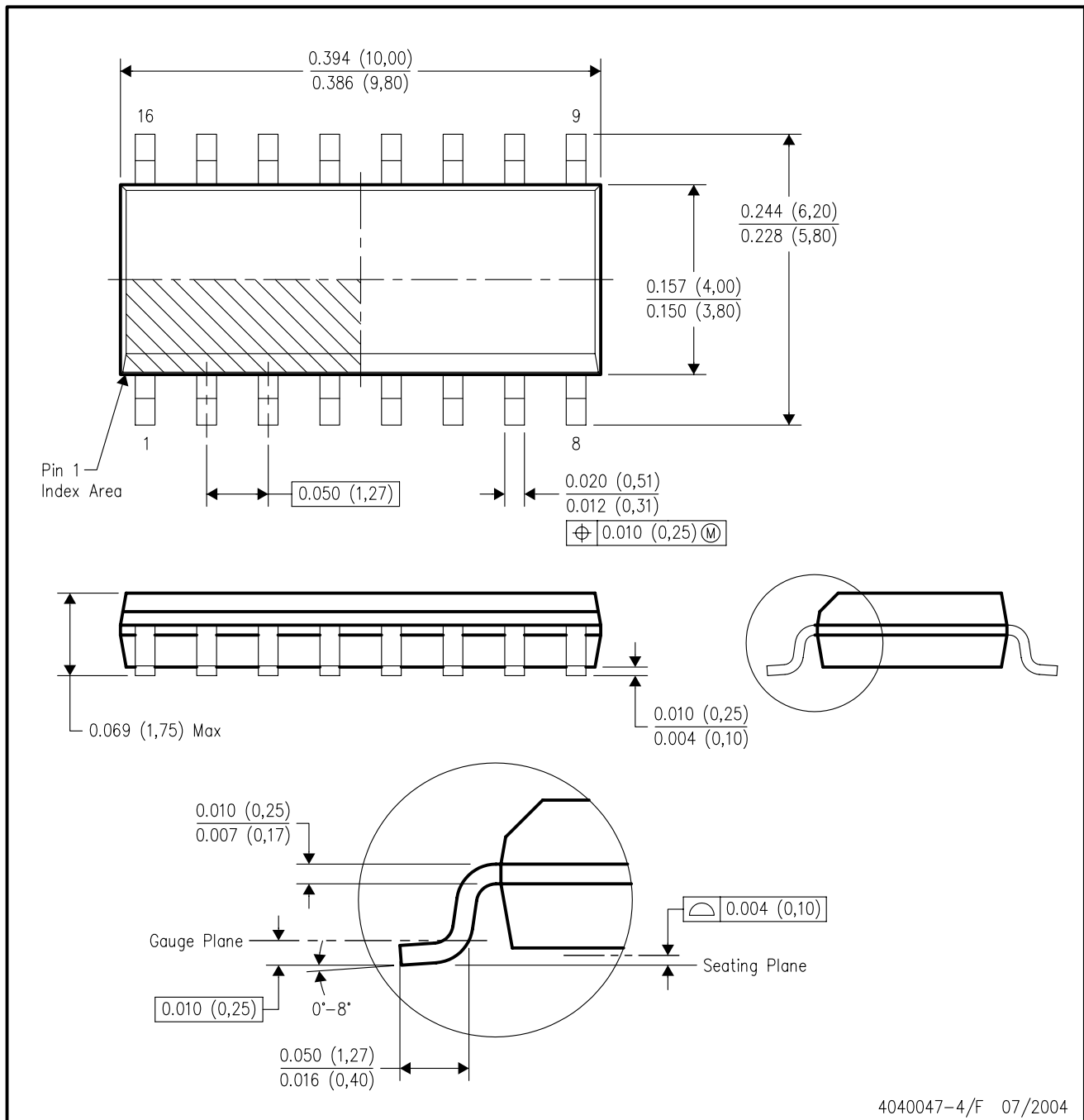
16 PINS SHOWN



- 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.

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-4/F 07/2004

- 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



- 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



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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