

## High-Speed CMOS Logic Quad D-Type Flip-Flop with Reset

August 1997 - Revised October 2003

### Features

- Common Clock and Asynchronous Reset on Four D-Type Flip-Flops
- Positive Edge Pulse Triggering
- Complementary Outputs
- Buffered Inputs
- 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  $V_{OL}$ ,  $V_{OH}$

advantage of standard CMOS ICs and the ability to drive 10 LSTTL devices.

Information at the D input is transferred to the Q,  $\bar{Q}$  outputs on the positive going edge of the clock pulse. All four Flip-Flops are controlled by a common clock (CP) and a common reset (MR). Resetting is accomplished by a low voltage level independent of the clock. All four Q outputs are reset to a logic 0 and all four  $\bar{Q}$  outputs to a logic 1.

### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD54HC175F3A	-55 to 125	16 Ld CERDIP
CD54HCT175F3A	-55 to 125	16 Ld CERDIP
CD74HC175E	-55 to 125	16 Ld PDIP
CD74HC175M	-55 to 125	16 Ld SOIC
CD74HC175MT	-55 to 125	16 Ld SOIC
CD74HC175M96	-55 to 125	16 Ld SOIC
CD74HCT175E	-55 to 125	16 Ld PDIP
CD74HCT175M	-55 to 125	16 Ld SOIC
CD74HCT175MT	-55 to 125	16 Ld SOIC
CD74HCT175M96	-55 to 125	16 Ld SOIC

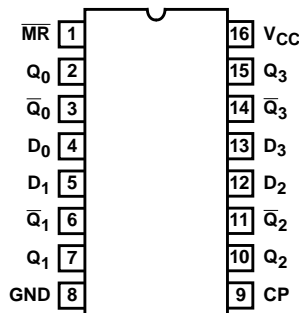
### Description

The 'HC175 and 'HCT175 are high speed Quad D-type Flip-Flops with individual D-inputs and Q,  $\bar{Q}$  complementary outputs. The devices are fabricated using silicon gate CMOS technology. They have the low power consumption

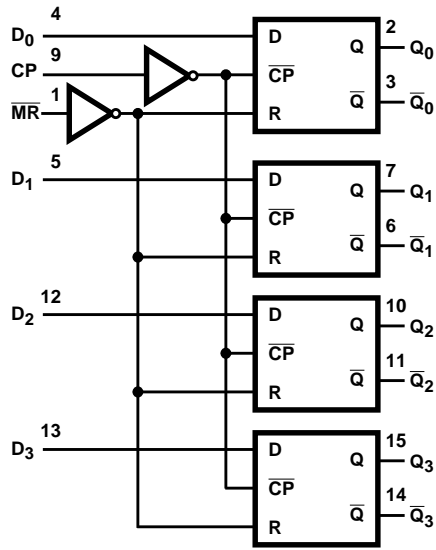
NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel. The suffix T denotes a small-quantity reel of 250.

### Pinout

CD54HC175, CD54HCT175  
(CERDIP)  
CD74HC175, CD74HCT175  
(PDIP, SOIC)  
TOP VIEW



**Functional Diagram**

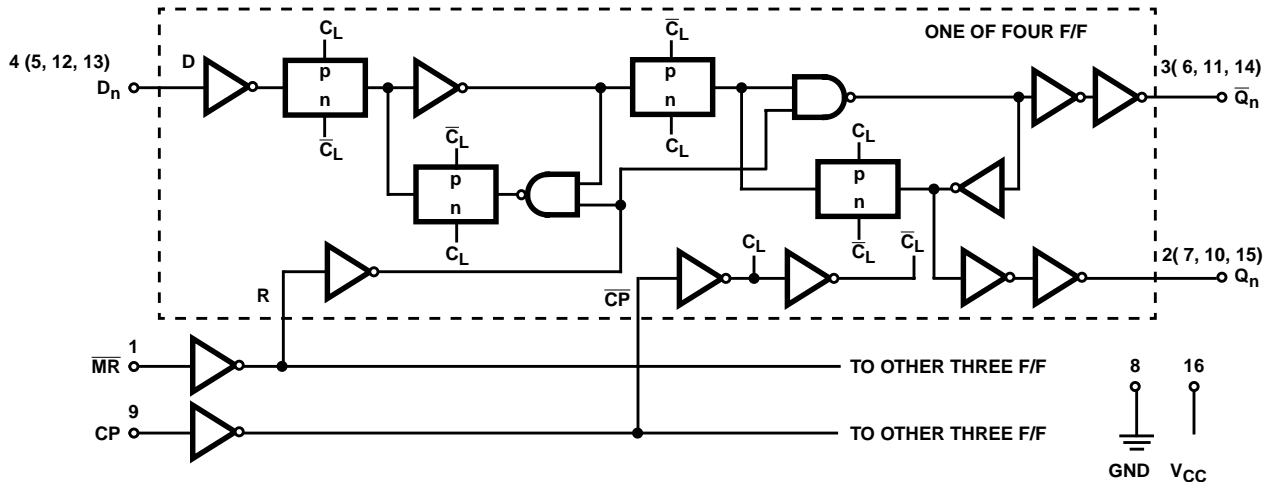


TRUTH TABLE

INPUTS			OUTPUTS	
RESET (MR)	CLOCK CP	DATA D <sub>n</sub>	Q <sub>n</sub>	$\bar{Q}_n$
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q <sub>0</sub>	$\bar{Q}_0$

H = High Voltage Level, L = Low Voltage Level, X = Don't Care, ↑ = Transition from Low to High Level, Q<sub>0</sub> = Level Before the Indicated Steady-State Input Conditions Were Established.

**Logic Diagram**



## CD54HC175, CD74HC175, CD54HCT175, CD74HCT175

### 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 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, $I_{CC}$ or $I_{GND}$ .....	$\pm 50mA$

### Thermal Information

Thermal Resistance (Typical, Note 1)	$\theta_{JA}$ ( $^{\circ}C/W$ )
E (PDIP) Package .....	67
M (SOIC) Package .....	73
Maximum Junction Temperature .....	$150^{\circ}C$
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 $V_{CC}$
Input Rise and Fall Time	
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	
<b>HC TYPES</b>												
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
			-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads	$V_{OH}$	$V_{IH}$ or $V_{IL}$	-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
			0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads	$V_{OL}$	$V_{IH}$ or $V_{IL}$	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	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu A$
Quiescent Device Current	$I_{CC}$	$V_{CC}$ or GND	0	6	-	-	8	-	80	-	160	$\mu A$

**CD54HC175, CD74HC175, CD54HCT175, CD74HCT175**

**DC Electrical Specifications (Continued)**

PARAMETER	SYMBOL	TEST CONDITIONS		V <sub>CC</sub> (V)	25°C			-40°C TO +85°C		-55°C TO 125°C		UNITS
		V <sub>I</sub> (V)	I <sub>O</sub> (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
<b>HCT TYPES</b>												
High Level Input Voltage	V <sub>IH</sub>	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V <sub>IL</sub>	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V
High Level Output Voltage CMOS Loads	V <sub>OH</sub>	V <sub>IH</sub> or V <sub>IL</sub>	-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 <sub>OL</sub>	V <sub>IH</sub> or V <sub>IL</sub>	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 <sub>I</sub>	V <sub>CC</sub> to GND	0	5.5	-	-	±0.1	-	±1	-	±1	μA
Quiescent Device Current	I <sub>CC</sub>	V <sub>CC</sub> or GND	0	5.5	-	-	8	-	80	-	160	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI <sub>CC</sub> (Note 2)	V <sub>CC</sub> -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA

**NOTES:**

2. For dual-supply systems theoretical worst case (V<sub>I</sub> = 2.4V, V<sub>CC</sub> = 5.5V) specification is 1.8mA.

**HCT Input Loading Table**

INPUT	UNIT LOADS
MR	1
CP	0.60
D	0.15

NOTE: Unit Load is ΔI<sub>CC</sub> limit specified in DC Electrical Specifications table, e.g. 360μA max at 25°C.

**Prerequisite For Switching Specifications**

PARAMETER	SYMBOL	TEST CONDITIONS	V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
<b>HC TYPES</b>											
Clock Pulse Width	t <sub>w</sub>	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
MR Pulse Width	t <sub>w</sub>	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns

**CD54HC175, CD74HC175, CD54HCT175, CD74HCT175**

**Prerequisite For Switching Specifications (Continued)**

PARAMETER	SYMBOL	TEST CONDITIONS	V <sub>CC</sub> (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Setup Time, Data to Clock	t <sub>SU</sub>	-	2	80	-	-	100	-	120	-	ns
			4.5	16	-	-	20	-	24	-	ns
			6	14	-	-	17	-	20	-	ns
Hold Time, Data to Clock	t <sub>H</sub>	-	2	5	-	-	5	-	5	-	ns
			4.5	5	-	-	5	-	5	-	ns
			6	5	-	-	5	-	5	-	ns
Removal Time, $\overline{MR}$ to Clock	t <sub>REM</sub>	-	2	5	-	-	5	-	5	-	ns
			4.5	5	-	-	5	-	5	-	ns
			6	5	-	-	5	-	5	-	ns
Clock Frequency	f <sub>MAX</sub>	-	2	6	-	-	5	-	4	-	MHz
			4.5	30	-	-	25	-	20	-	MHz
			6	35	-	-	29	-	23	-	MHz

**HCT TYPES**

Clock Pulse Width	t <sub>w</sub>	-	4.5	20	-	-	25	-	30	-	ns
$\overline{MR}$ Pulse Width	t <sub>w</sub>	-	4.5	20	-	-	25	-	30	-	ns
Setup Time Data to Clock	t <sub>SU</sub>	-	4.5	20	-	-	25	-	30	-	ns
Hold Time Data to Clock	t <sub>H</sub>	-	4.5	5	-	-	5	-	5	-	ns
Removal Time $\overline{MR}$ to Clock	t <sub>REM</sub>	-	4.5	5	-	-	5	-	5	-	ns
Clock Frequency	f <sub>MAX</sub>	-	4.5	25	-	-	20	-	16	-	MHz

**Switching Specifications** Input t<sub>r</sub>, t<sub>f</sub> = 6ns

PARAMETER	SYMBOL	TEST CONDITIONS	V <sub>CC</sub> (V)	25°C		-40°C TO 85°C	-55°C TO 125°C	UNITS		
				TYP	MAX	MAX	MAX			
Propagation Delay, Clock to Q or $\overline{Q}$	t <sub>PLH</sub> , t <sub>PHL</sub>	C <sub>L</sub> = 50pF	2	-	175	220	265	ns		
			4.5	-	35	44	53	ns		
			6	-	30	37	45	ns		
		C <sub>L</sub> = 15pF	5	14	-	-	-	ns		
			Propagation Delay, $\overline{MR}$ to Q or $\overline{Q}$	C <sub>L</sub> = 50pF	2	-	175	220	265	ns
					4.5	-	35	44	53	ns
6	-	30			37	45	ns			
C <sub>L</sub> = 15pF	5	14	-	-	-	ns				
	Output Transition Times	C <sub>L</sub> = 50pF	2	-	75	95	110	ns		
			4.5	-	15	19	22	ns		
6			-	13	16	19	ns			
Input Capacitance	C <sub>IN</sub>	-	-	-	10	10	10	pF		
Power Dissipation Capacitance (Notes 3, 4)	C <sub>PD</sub>	-	5	65	-	-	-	pF		

**CD54HC175, CD74HC175, CD54HCT175, CD74HCT175**

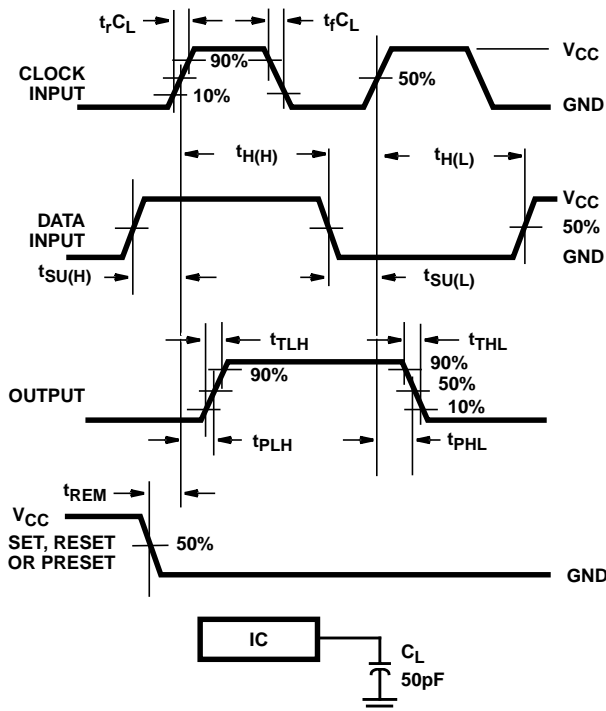
**Switching Specifications** Input  $t_r, t_f = 6\text{ns}$  (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	$V_{CC}$ (V)	25°C		-40°C TO 85°C	-55°C TO 125°C	UNITS
				TYP	MAX	MAX	MAX	
<b>HCT TYPES</b>								
Propagation Delay, Clock to Q or $\bar{Q}$	$t_{PLH}, t_{PHL}$	$C_L = 50\text{pF}$	4.5	-	33	41	50	ns
		$C_L = 15\text{pF}$	5	13	-	-	-	ns
Propagation Delay, $\overline{MR}$ to Q or $\bar{Q}$	$t_{PLH}, t_{PHL}$	$C_L = 50\text{pF}$	4.5	-	35	44	53	ns
		$C_L = 15\text{pF}$	5	17	-	-	-	ns
Output Transition Times	$t_{TLH}, t_{THL}$	$C_L = 50\text{pF}$	4.5	-	15	19	22	ns
Input Capacitance	$C_{IN}$	-	-	-	10	10	10	pF
Power Dissipation Capacitance (Notes 3, 4)	$C_{PD}$	-	5	67	-	-	-	pF

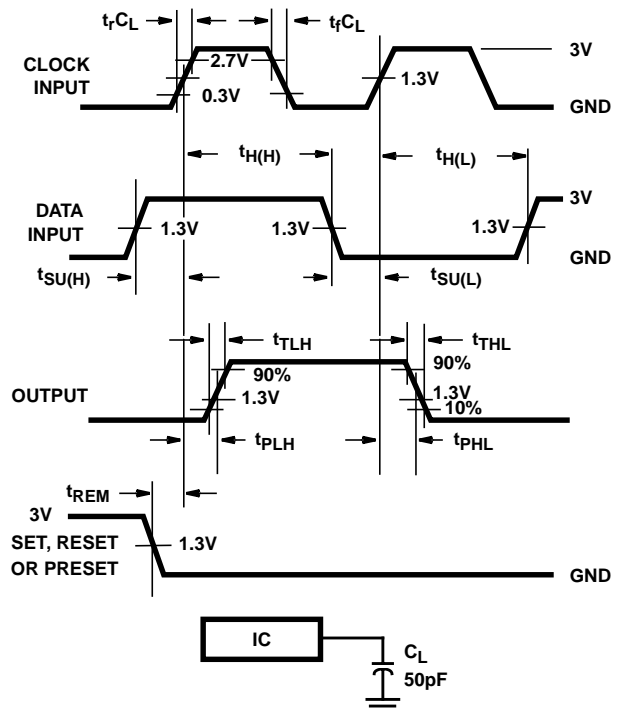
**NOTES:**

- $C_{PD}$  is used to determine the dynamic power consumption, per flip-flop.
- $P_D = V_{CC}^2 f_i + \sum (C_L V_{CC}^2 + f_O)$  where  $f_i$  = Input Frequency,  $f_O$  = Output Frequency,  $C_L$  = Output Load Capacitance,  $V_{CC}$  = Supply Voltage.

**Test Circuits and Waveforms**



**FIGURE 1. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS**



**FIGURE 2. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS**

PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
5962-8970101EA	ACTIVE	CDIP	J	16	1	TBD	Call TI	Level-NC-NC-NC
CD54HC175F3A	ACTIVE	CDIP	J	16	1	TBD	Call TI	Level-NC-NC-NC
CD54HCT175F3A	ACTIVE	CDIP	J	16	1	TBD	Call TI	Level-NC-NC-NC
CD74HC175E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC175EE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC175M	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HC175M96	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HC175M96E4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HC175ME4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HC175MT	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HC175MTE4	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HCT175E	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HCT175EE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HCT175M	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HCT175M96	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HCT175M96E4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HCT175ME4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HCT175MT	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD74HCT175MTE4	ACTIVE	SOIC	D	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**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 (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> 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.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

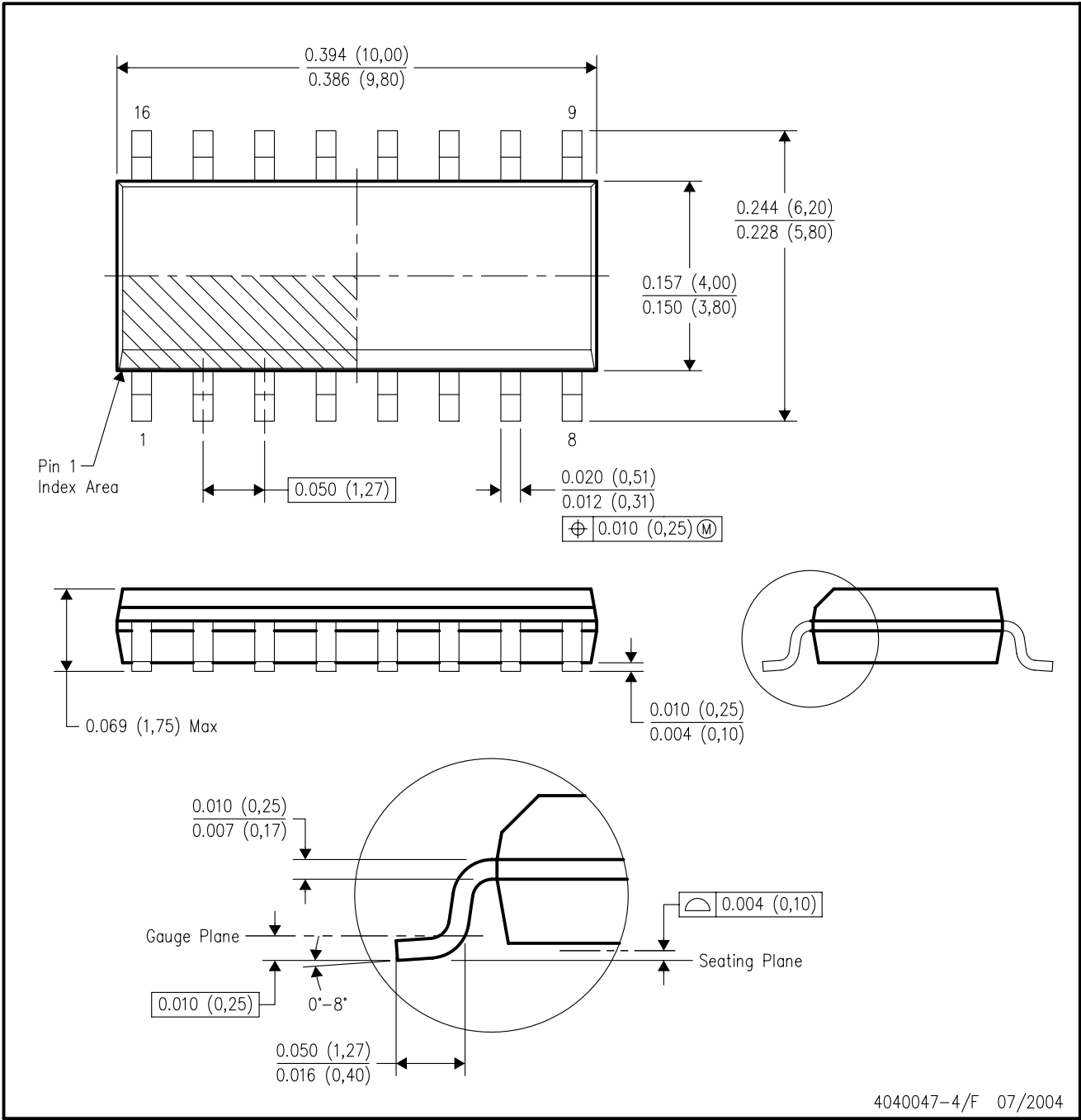
16 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 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.

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