

High-Speed CMOS Logic Octal D-Type Flip-Flop, Three-State Inverting Positive-Edge Triggered

Features

- Buffered Inputs
- Common Three-State Output-Enable Control
- Three-State Outputs
- Bus Line Driving Capability
- Typical Propagation Delay = 13ns at $V_{CC} = 5V$, $C_L = 15pF$, $T_A = 25^\circ C$ (Clock to Output)
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . $-55^\circ C$ to $125^\circ C$
- 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}

Description

The 'HC534, 'HCT534, 'HC564, and 'HCT564 are high speed Octal D-Type Flip-Flops manufactured with silicon gate CMOS technology. They possess the low power consumption of standard CMOS integrated circuits, as well as the ability to drive 15 LSTTL loads. Due to the large output drive capability and the three-state feature, these devices are ideally suited for interfacing with bus lines in a bus organized system. The two types are functionally identical and differ only in their pinout arrangements.

The 'HC534, 'HCT534, 'HC564, and 'HCT564 are positive edge triggered flip-flops. Data at the D inputs, meeting the setup and hold time requirements, are inverted and transferred to the Q outputs on the positive going transition of the CLOCK input. When a high logic level is applied to the OUTPUT ENABLE input, all outputs go to a high impedance state, regardless of what signals are present at the other inputs and the state of the storage elements.

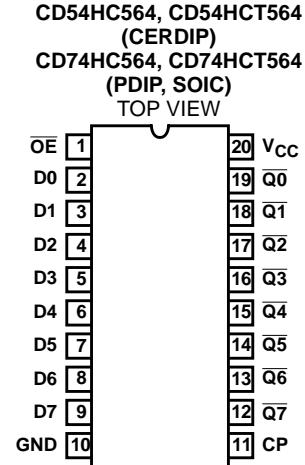
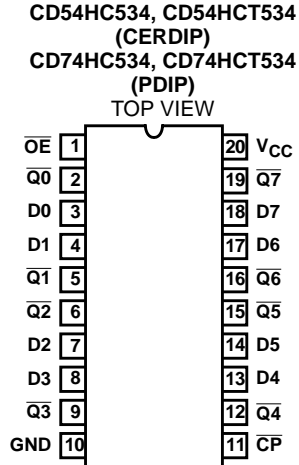
The HCT logic family is speed, function, and pin compatible with the standard LS logic family.

Ordering Information

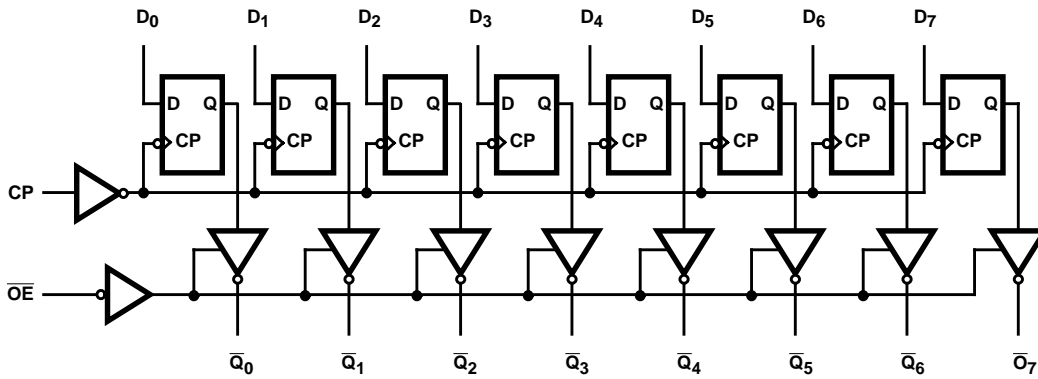
PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD54HC534F3A	-55 to 125	20 Ld CERDIP
CD54HC564F3A	-55 to 125	20 Ld CERDIP
CD54HCT534F3A	-55 to 125	20 Ld CERDIP
CD54HCT564F3A	-55 to 125	20 Ld CERDIP
CD74HC534E	-55 to 125	20 Ld PDIP
CD74HC564E	-55 to 125	20 Ld PDIP
CD74HC564M	-55 to 125	20 Ld SOIC
CD74HC564M96	-55 to 125	20 Ld SOIC
CD74HCT534E	-55 to 125	20 Ld PDIP
CD74HCT564E	-55 to 125	20 Ld PDIP
CD74HCT564M	-55 to 125	20 Ld SOIC

CD54/74HC534, CD54/74HCT534, CD54/74HC564, CD54/74HCT564

Pinouts



Functional Diagram



TRUTH TABLE

INPUTS			OUTPUT
OE	CP	D _n	Q _n
L	↑	H	L
L	↑	L	H
L	L	X	No Change
H	X	X	Z

H = High Level (Steady State)
L = Low Level (Steady State)
X = Don't Care
↑ = Transition from Low to High Level
Z = High Impedance State

CD54/74HC534, CD54/74HCT534, CD54/74HC564, CD54/74HCT564

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 Drain Current, per Output, I_O	
For $-0.5V < V_O < V_{CC} + 0.5V$	$\pm 35mA$
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 1)	θ_{JA} (°C/W)
E (PDIP) Package	69
M (SOIC) Package	58
Maximum Junction Temperature	150°C
Maximum Storage Temperature Range	-65°C to 150°C
Maximum Lead Temperature (Soldering 10s)	300°C (SOIC - Lead Tips Only)

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	
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 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	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads	V_{OH}	V_{IH} or V_{IL}	-	-	-	-	-	-	-	-	-	V	
			-6	-6	4.5	3.98	-	-	3.84	-	3.7	-	V
			-7.8	-7.8	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads	V_{OL}	V_{IH} or V_{IL}	-	-	-	-	-	-	-	-	-	V	
			6	6	4.5	-	-	0.26	-	0.33	-	0.4	V
			7.8	7.8	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	± 0.1	-	± 1	-	± 1	μA	

CD54/74HC534, CD54/74HCT534, CD54/74HC564, CD54/74HCT564

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	-	-	8	-	80	-	160	μA
Three- State Leakage Current	V _{IL} or V _{IH}	V _O = V _{CC} or GND	-	6	-	-	±0.5	-	±5.0	-	±10	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			-6	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			6	4.5	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I _I	V _{CC} and GND	0	5.5	-	-	±0.1	-	±1	-	±1	μA
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	5.5	-	-	8	-	80	-	160	μA
Three- State Leakage Current	V _{IL} or V _{IH}	V _O = V _{CC} or GND	-	5.5	-	-	±0.5	-	±5.0	-	±10	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI _{CC} (Note 2)	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
D0 - D7	0.15
CP	0.30
OE	0.55

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

CD54/74HC534, CD54/74HCT534, CD54/74HC564, CD54/74HCT564

Prerequisite for Switching Specifications

PARAMETER	SYMBOL	V _{CC} (V)	25°C			-40°C TO 85°C			-55°C TO 125°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
HC TYPES												
Maximum Clock Frequency	f _{MAX}	2	6	-	-	5	-	-	4	-	-	MHz
		4.5	30	-	-	25	-	-	20	-	-	MHz
		6	35	-	-	29	-	-	23	-	-	MHz
Clock Pulse Width	t _W	2	80	-	-	100	-	-	120	-	-	ns
		4.5	16	-	-	20	-	-	24	-	-	ns
		6	14	-	-	17	-	-	20	-	-	ns
Setup Time Data to Clock	t _{SU}	2	60	-	-	75	-	-	90	-	-	ns
		4.5	12	-	-	15	-	-	18	-	-	ns
		6	10	-	-	13	-	-	15	-	-	ns
Hold Time Data to Clock	t _H	2	5	-	-	5	-	-	5	-	-	ns
		4.5	5	-	-	5	-	-	5	-	-	ns
		6	5	-	-	5	-	-	5	-	-	ns
HCT TYPES												
Maximum Clock Frequency	f _{MAX}	4.5	25	-	-	20	-	-	16	-	-	MHz
Clock Pulse Width	t _W	4.5	20	-	-	25	-	-	30	-	-	ns
Setup Time Data to Clock	t _{SU}	4.5	20	-	-	25	-	-	30	-	-	ns
Hold Time Data to Clock (534)	t _H	4.5	5	-	-	5	-	-	5	-	-	ns
Hold Time Data to Clock (564)	t _H	4.5	3	-	-	3	-	-	3	-	-	ns

Switching Specifications C_L = 50pF, 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 Clock to Output	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	165	-	205	-	250	ns
			4.5	-	-	33	-	41	-	50	ns
		C _L = 15pF	5	-	13	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	28	-	35	-	43	ns
Output Disable to Q (534)	t _{PLZ} , t _{PHZ}	C _L = 50pF	2	-	-	150	-	190	-	225	ns
			4.5	-	-	30	-	38	-	45	ns
		C _L = 15pF	5	-	12	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	26	-	33	-	38	ns

CD54/74HC53A, CD54/74HCT53A, CD54/74HC56A, CD54/74HCT56A

Switching Specifications $C_L = 50\text{pF}$, 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 Disable to Q (564)	t_{PLZ}, t_{PHZ}	$C_L = 50\text{pF}$	2	-	-	135	-	170	-	205	ns
			4.5	-	-	27	-	34	-	41	ns
		$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	-	23	-	29	-	35	ns
Output Enable to Q	t_{PZL}, t_{PZH}	$C_L = 50\text{pF}$	2	-	-	150	-	190	-	225	ns
			4.5	-	-	30	-	38	-	45	ns
		$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	-	26	-	33	-	38	ns
Maximum Clock Frequency	f_{MAX}	$C_L = 15\text{pF}$	5	-	60	-	-	-	-	MHz	
Output Transition Time	t_{THL}, t_{TLH}	$C_L = 50\text{pF}$	2	-	-	60	-	75	-	90	ns
			4.5	-	-	12	-	15	-	18	ns
			6	-	-	10	-	13	-	15	ns
Input Capacitance	C_I	$C_L = 50\text{pF}$	-	10	-	10	-	10	-	10	pF
Three-State Output Capacitance	C_O	-	-	20	-	20	-	20	-	20	pF
Power Dissipation Capacitance (Notes 3, 4)	C_{PD}	-	5	-	32	-	-	-	-	-	pF

HCT TYPES

Propagation Delay Clock to Output	t_{PHL}, t_{PLH}	$C_L = 50\text{pF}$	4.5	-	-	35	-	44	-	53	ns
			$C_L = 15\text{pF}$	5	-	14	-	-	-	-	-
Output Disable to Q	t_{PLZ}, t_{PHZ}	$C_L = 50\text{pF}$	4.5	-	-	30	-	38	-	45	ns
			$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-
Output Enable to Q	t_{PZL}, t_{PZH}	$C_L = 50\text{pF}$	4.5	-	-	35	-	44	-	53	ns
			$C_L = 15\text{pF}$	5	-	14	-	-	-	-	-
Maximum Clock Frequency	f_{MAX}	$C_L = 15\text{pF}$	5	-	50	-	-	-	-	-	MHz
Output Transition Time	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	-	12	-	15	-	18	ns
Input Capacitance	C_I	$C_L = 50\text{pF}$	-	10	-	10	-	10	-	10	pF
Three-State Output Capacitance	C_O	-	-	20	-	20	-	20	-	20	pF
Power Dissipation Capacitance (Notes 3, 4)	C_{PD}	-	5	-	36	-	-	-	-	-	pF

NOTES:

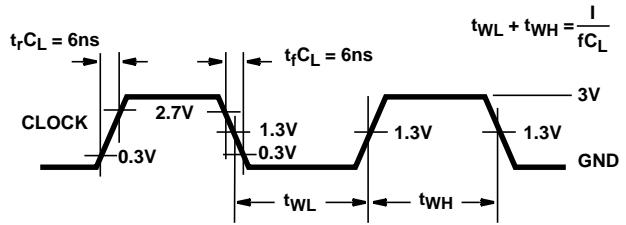
- C_{PD} is used to determine the dynamic power consumption, per package.
- $P_D = C_{PD} V_{CC}^2 f_i + \sum C_L V_{CC}^2 f_O$ where f_i = Input Frequency, f_O = Output Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms



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



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



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

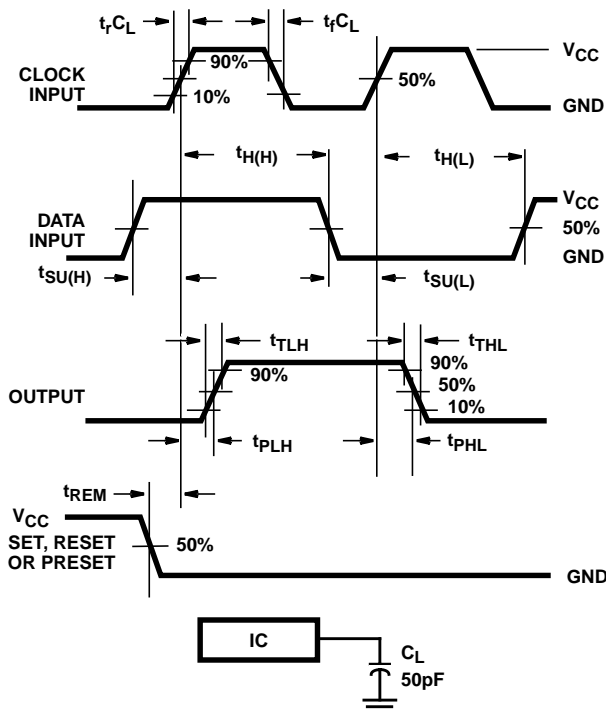


FIGURE 5. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

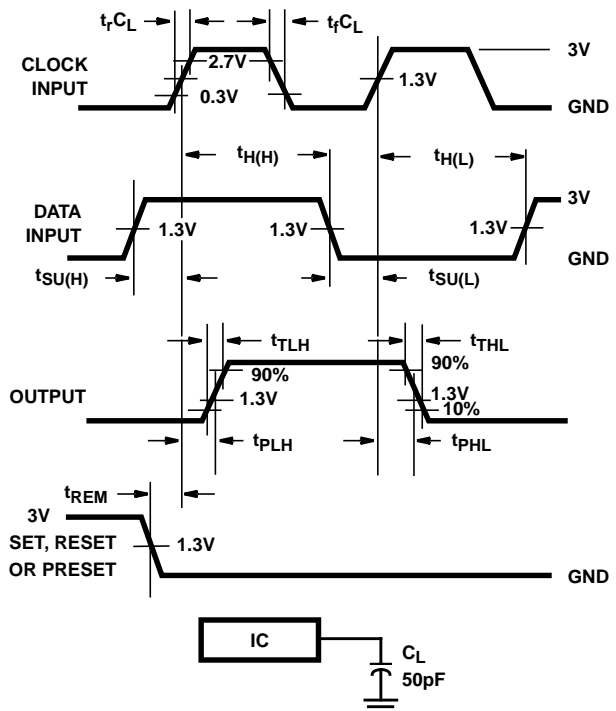


FIGURE 6. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

Test Circuits and Waveforms (Continued)

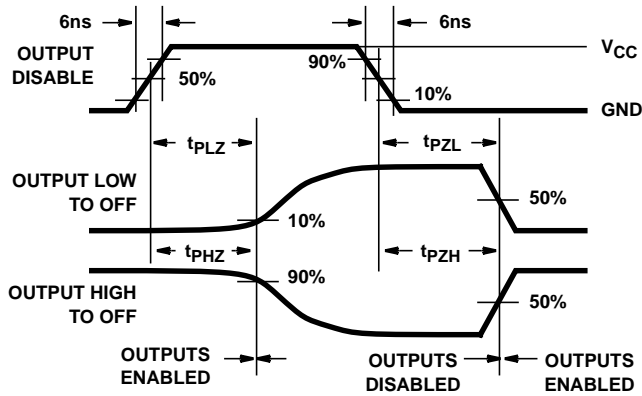


FIGURE 7. HC THREE-STATE PROPAGATION DELAY WAVEFORM

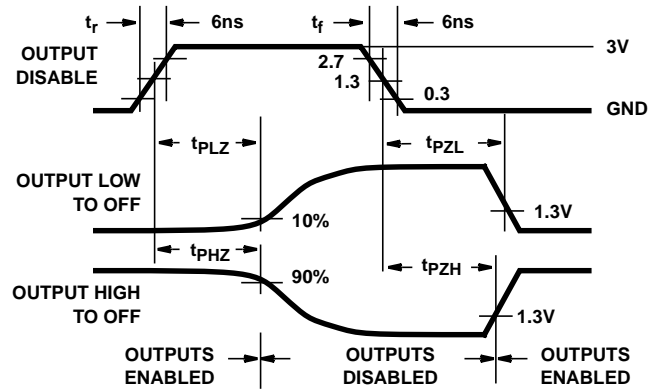
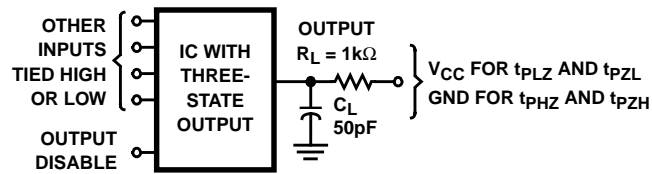


FIGURE 8. HCT THREE-STATE PROPAGATION DELAY WAVEFORM



NOTE: Open drain waveforms t_{PLZ} and t_{PZL} are the same as those for three-state shown on the left. The test circuit is Output $R_L = 1k\Omega$ to V_{CC} , $C_L = 50pF$.

FIGURE 9. HC AND HCT THREE-STATE PROPAGATION DELAY TEST CIRCUIT

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
5962-8681401RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
5962-8681501RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
5962-8984901RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
CD54HC534F3A	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
CD54HC564F3A	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
CD54HCT534F3A	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
CD54HCT564F3A	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
CD74HC534E	ACTIVE	PDIP	N	20	20	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC564E	ACTIVE	PDIP	N	20	20	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HC564M	ACTIVE	SOIC	DW	20	25	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
CD74HC564M96	ACTIVE	SOIC	DW	20	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
CD74HCT534E	ACTIVE	PDIP	N	20	20	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HCT564E	ACTIVE	PDIP	N	20	20	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD74HCT564M	ACTIVE	SOIC	DW	20	25	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-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.

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)



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

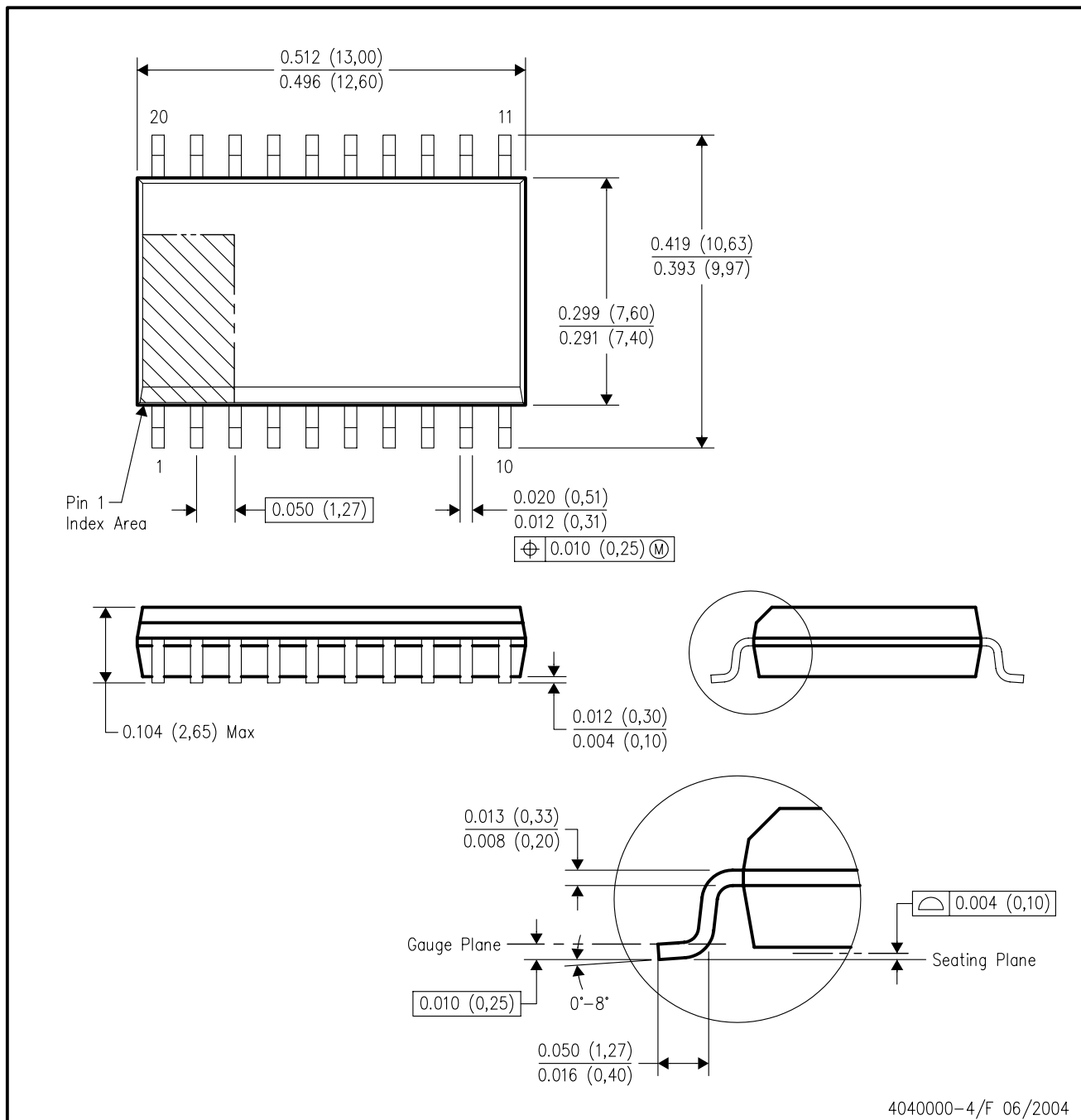


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - D The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002

DW (R-PDSO-G20)

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-013 variation AC.

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