

CD74HC173, CD74HCT173

High Speed CMOS Logic Quad D-Type Flip-Flop, Three-State

February 1998

Features

- Three-State Buffered Outputs
- Gated Input and Output Enables
- 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, $I_1 \leq 1\mu A$ at V_{OL} , V_{OH}

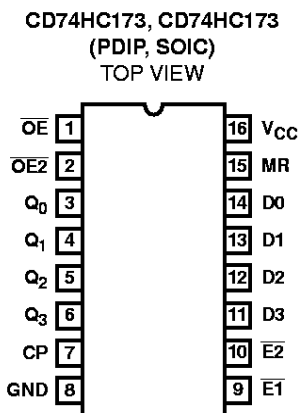
Description

The Harris CD74HC173 and CD74HCT173 high speed three-state quad D-type flip-flops are fabricated with silicon gate CMOS technology. They possess the low power consumption of standard CMOS Integrated circuits, and can operate at speeds comparable to the equivalent low power Schottky devices. The buffered outputs can drive 15 LSTTL loads. The large output drive capability and three-state feature make these parts ideally suited for interfacing with bus lines in bus oriented systems.

The four D-type flip-flops operate synchronously from a common clock. The outputs are in the three-state mode when either of the two output disable pins are at the logic "1" level. The input ENABLES allow the flip-flops to remain in their present states without having to disrupt the clock. If either of the 2 input ENABLES are taken to a logic "1" level, the Q outputs are fed back to the inputs, forcing the flip-flops to remain in the same state. Reset is enabled by taking the MASTER RESET (MR) input to a logic "1" level. The data outputs change state on the positive going edge of the clock.

The CD74HCT173 logic family is functionally, as well as pin compatible with the standard 74LS logic family.

Pinout



Ordering Information

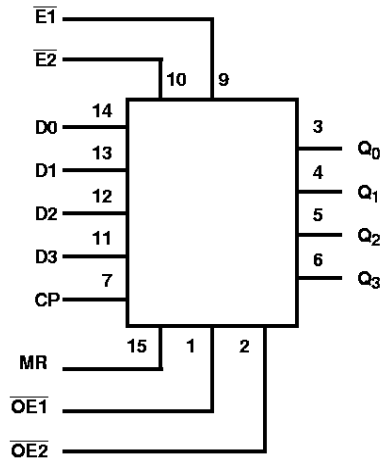
PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CD74HC173E	-55 to 125	16 Ld PDIP	E16.3
CD74HCT173E	-55 to 125	16 Ld PDIP	E16.3
CD74HC173M	-55 to 125	16 Ld SOIC	M16.15
CD74HCT173M	-55 to 125	16 Ld SOIC	M16.15

NOTES:

1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer and die for this part number is available which meets all electrical specifications. Please contact your local sales office or Harris customer service for ordering information.

CD74HC173, CD74HCT173

Functional Diagram



TRUTH TABLE

		INPUTS		DATA	OUTPUT
		DATA ENABLE			
MR	CP	$\overline{E1}$	$\overline{E2}$	D	Q_n
H	X	X	X	X	L
L	L	X	X	X	Q_0
L	↑	H	X	X	Q_0
L	↑	X	H	X	Q_0
L	↑	L	L	L	L
L	↑	L	L	H	H

NOTE:

When either $\overline{OE1}$ or $\overline{OE2}$ (or both) is (are) high the output is disabled to the high-impedance state, however, sequential operation of the flip-flops is not affected.

H = High Voltage Level

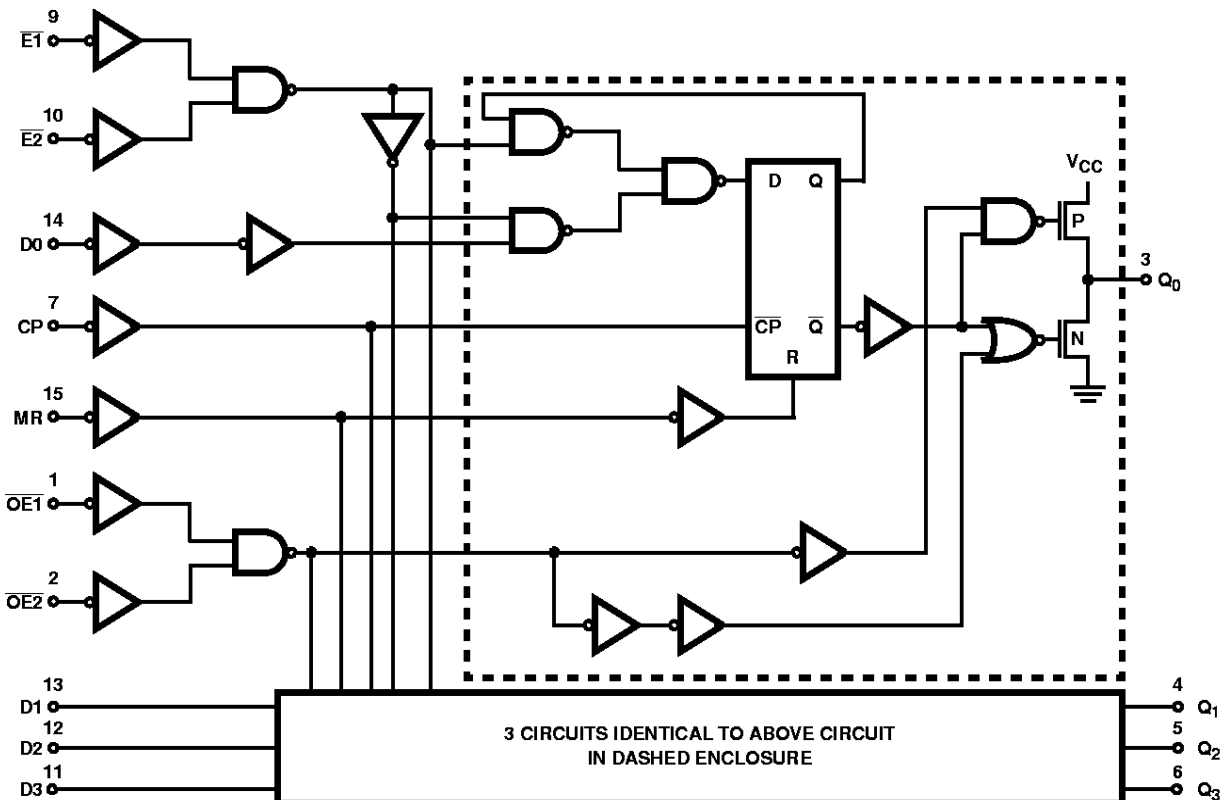
L = Low Voltage Level

X = Irrelevant

↑ = Transition from Low to High Level

Q_0 = Level Before the Indicated Steady-State Input Conditions Were Established

Logic Diagram



CD74HC173, CD74HCT173

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}	$\pm 70mA$

Thermal Information

Thermal Resistance (Typical, Note 3)	θ_{JA} ($^{\circ}C/W$)
PDIP Package	90
SOIC Package	160
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:

- θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

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
			-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}	-6	4.5	3.98	-	-	3.84	-	3.7	-	V
			-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	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}	6	4.5	-	-	0.26	-	0.33	-	0.4	V
			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
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	μA

CD74HC173, CD74HCT173

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	
Three-State Leakage Current	I_{OZ}	V_{IL} or V_{IH}	-	6	-	-	±0.5	-	±0.5	-	±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} to 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
Additional Quiescent Device Current Per Input Pin: 1 Unit Load (Note 4)	ΔI_{CC}	V_{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA
Three-State Leakage Current	I_{OZ}	V_{IL} or V_{IH}	-	5.5	-	-	±0.5	-	±5.0	-	±10	μA

NOTE:

4. 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-D3	0.15
$\overline{E1}$ and $\overline{E2}$	0.15
CP	0.25
MR	0.2
$\overline{OE1}$ and $\overline{OE2}$	0.5

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

CD74HC173, CD74HCT173

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

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C		-40°C TO 85°C	-55°C TO 125°C	UNITS
				TYP	MAX	MAX	MAX	
HC TYPES								
Propagation Delay, Clock to Output	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	2	-	200	250	300	ns
			4.5	-	40	50	60	ns
		$C_L = 15\text{pF}$	5	17	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	34	43	51	ns
Propagation Delay, MR to Output	t_{PHL}	$C_L = 50\text{pF}$	2	-	175	220	265	ns
			4.5	-	35	44	53	ns
		$C_L = 15\text{pF}$	5	12	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	30	37	45	ns
Propagation Delay Output Enable to Q (Figure 6)	t_{PLZ}, t_{PHZ} t_{PZL}, t_{PZH}	$C_L = 50\text{pF}$	2	-	150	190	225	ns
		$C_L = 50\text{pF}$	4.5	-	30	38	45	ns
		$C_L = 15\text{pF}$	5	12	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	26	33	38	ns
Output Transition Times	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	2	-	60	75	90	ns
			4.5	-	12	15	18	ns
			6	-	10	13	15	ns
Maximum Clock Frequency	f_{MAX}	$C_L = 15\text{pF}$	5	60	-	-	-	MHz
Input Capacitance	C_{IN}	-	-	-	10	10	10	pF
Three-State Output Capacitance	C_O	-	-	-	10	10	10	pF
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	29	-	-	-	pF
HCT TYPES								
Propagation Delay, Clock to Output	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	40	50	60	ns
		$C_L = 15\text{pF}$	5	17	-	-	-	ns
Propagation Delay, MR to Output	t_{PHL}	$C_L = 50\text{pF}$	4.5	-	44	55	66	ns
		$C_L = 15\text{pF}$	5	18	-	-	-	ns
Propagation Delay Output Enable to Q (Figure 6)	t_{PZL}, t_{PZH}	$C_L = 50\text{pF}$	2	-	150	190	225	ns
		$C_L = 50\text{pF}$	4.5	-	30	38	45	ns
		$C_L = 15\text{pF}$	5	14	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	26	33	38	ns
Output Transition Times	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	15	19	22	ns
Maximum Clock Frequency	f_{MAX}	$C_L = 15\text{pF}$	5	60	-	-	-	MHz
Input Capacitance	C_{IN}	-	-	-	10	10	10	pF
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	34	-	-	-	pF

NOTES:

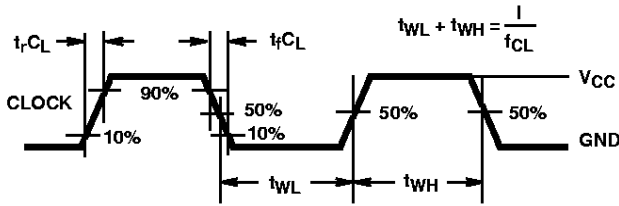
5. C_{PD} is used to determine the dynamic power consumption, per package.
6. $P_D = V_{CC}^2 f_i + \sum (C_L V_{CC}^2 + f_O)$ where f_i = Input Frequency, f_O = Output Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

CD74HC173, CD74HCT173

Prerequisite For Switching Specifications

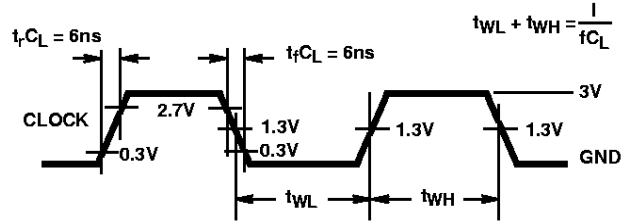
PARAMETER	SYMBOL	V _{CC} (V)	25°C		-40°C TO 85°C		-55°C TO 125°C		UNITS
			MIN	MAX	MIN	MAX	MIN	MAX	
HC TYPES									
Maximum Clock Frequency	f _{MAX}	2	6	-	5	-	4	-	MHz
		4.5	30	-	24	-	20	-	MHz
		6	35	-	28	-	24	-	MHz
MR Pulse Width	t _w	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Clock Pulse Width	t _w	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Set-up Time, Data to Clock and \bar{E} 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	3	-	3	-	3	-	ns
		4.5	3	-	3	-	3	-	ns
		6	3	-	3	-	3	-	ns
Hold Time, \bar{E} to Clock	t _H	2	0	-	0	-	0	-	ns
		4.5	0	-	0	-	0	-	ns
		6	0	-	0	-	0	-	ns
Removal Time, MR to Clock	t _{REM}	2	60	-	75	-	90	-	ns
		4.5	12	-	15	-	18	-	ns
		6	10	-	13	-	15	-	ns
HCT TYPES									
Maximum Clock Frequency	f _{MAX}	4.5	20	-	16	-	13	-	MHz
MR Pulse Width	t _w	4.5	15	-	19	-	22	-	ns
Clock Pulse Width	t _w	4.5	25	-	31	-	38	-	ns
Set-up Time, \bar{E} to Clock	t _{SU}	4.5	12	-	15	-	18	-	ns
Set-up Time, Data to Clock	t _{SU}	4.5	18	-	23	-	27	-	ns
Hold Time, Data to Clock	t _H	4.5	0	-	0	-	0	-	ns
Hold Time, \bar{E} to Clock	t _H	4.5	0	-	0	-	0	-	ns
Removal Time, MR to Clock	t _{REM}	4.5	12	-	15	-	18	-	ns

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

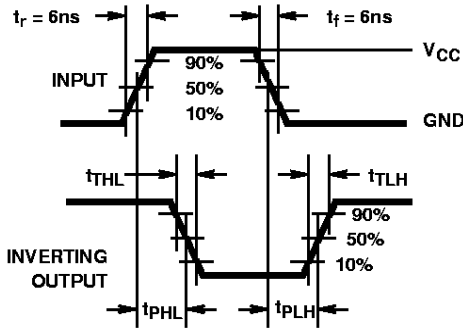


FIGURE 3. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

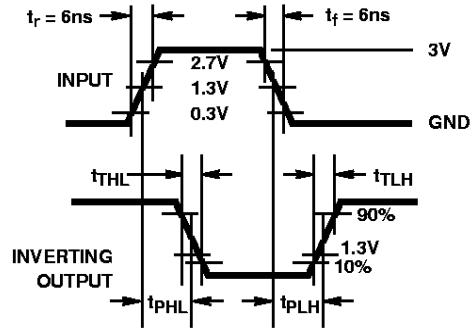


FIGURE 4. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

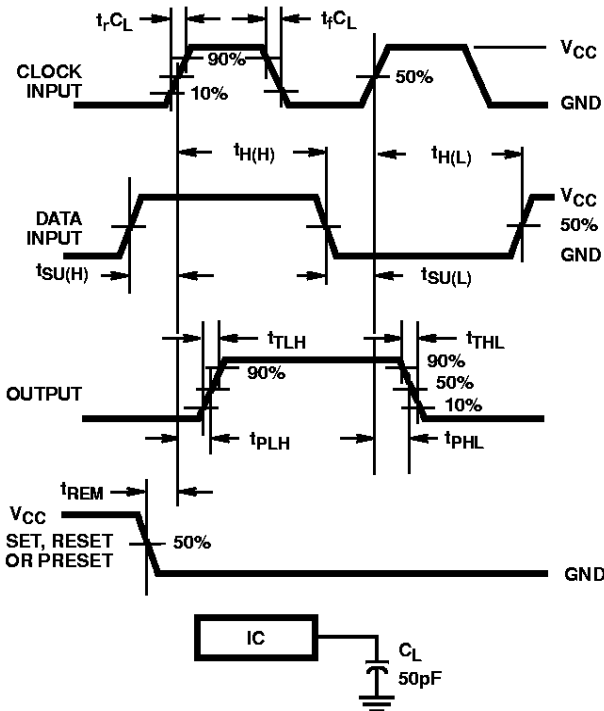


FIGURE 5. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

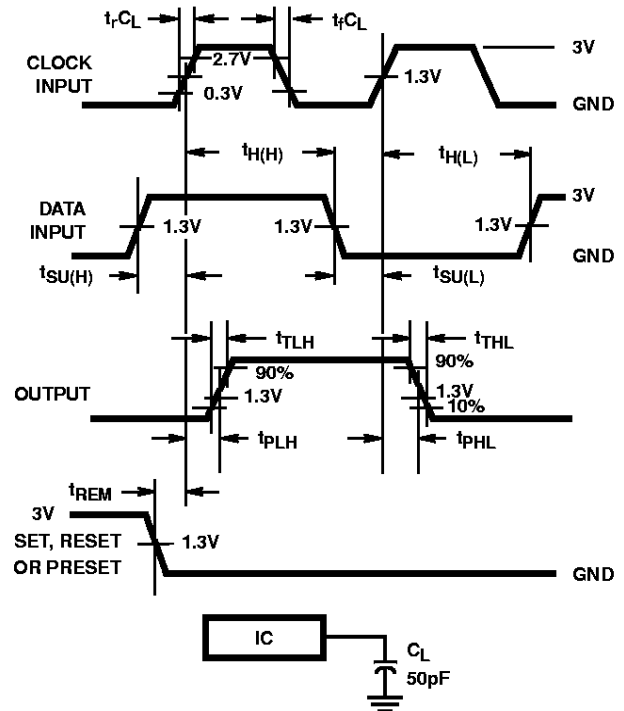


FIGURE 6. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

Test Circuits and Waveforms (Continued)

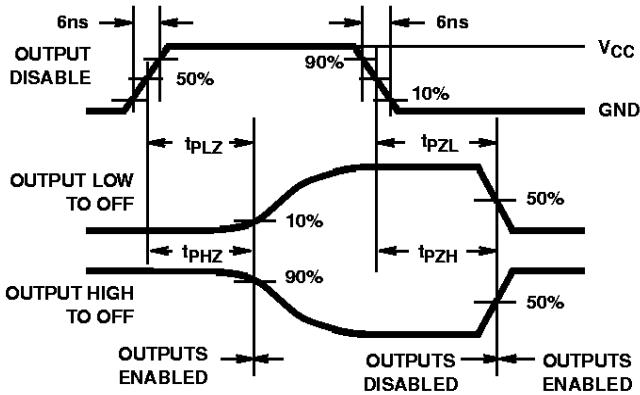


FIGURE 7. HC THREE-STATE PROPAGATION DELAY WAVEFORM

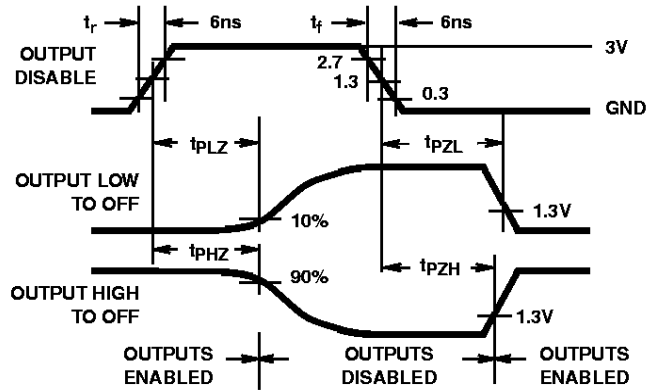
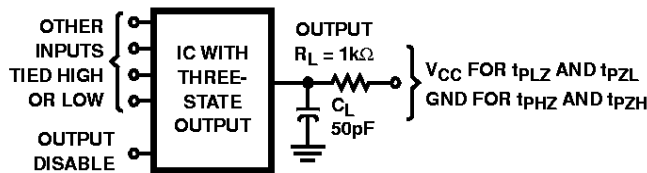


FIGURE 8. HCT THREE-STATE PROPAGATION DELAY WAVEFORM



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

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