TEXAS INSTRUMENTS

Data sheet acquired from Harris Semiconductor
SCHS138

August 1997

CD74HC93, CD74HCT93

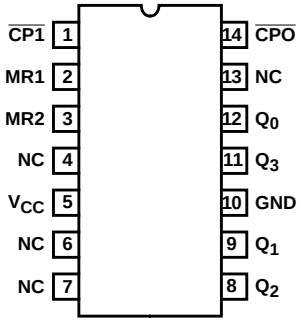
High Speed CMOS Logic 4-Bit Binary Ripple Counter

Features

- **Can Be Configured to Divide By 2, 8, and 16**
- **Asynchronous Master Reset**
- **Fanout (Over Temperature Range)**
  - **Standard Outputs . . . . . 10 LSTTL Loads**
  - **Bus Driver Outputs . . . . . 15 LSTTL Loads**
- **Wide Operating Temperature Range . . . -55^{O}C to 125^{O}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

CD74HC93, CD74HCT93
(PDIP, SOIC)
TOP VIEW



Description

The Harris CD74HC93 and CD74HCT93 are high speed silicon-gate CMOS devices and are pin-compatible with low power Schottky TTL (LSTTL). These 4-bit binary ripple counters consist of four master-slave flip-flops internally connected to provide a divide-by-two-section and a divid- by-eight-section. Each section has a separate clock input ($\overline{CP0}$ and $\overline{CP1}$) to innate state changes of the counter on the HIGH to LOW clock transition. Sate changes of the Qn outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used for clocks or strobes.

A gated AND asynchronous master reset (MR1 and MR2 is provided which overrides both clocks and resets (clears) all flip-flops.

Because the output from the divide by two section is not internally connected to the succeeding stages, the device may be operated in various counting modes.

In a 4-bit ripple counter the output Q0 must be connected externally to input $\overline{CP1}$. The input count pulses are applied to clock input $\overline{CP0}$. Simultaneous frequency divisions of 2, 4, 8, and 16 are performed at the Q0, Q1, Q2, and Q3 outputs as shown in the function table. As a 3-bit ripple counter the input count pulses are applied to input $\overline{CP1}$.

Simultaneous frequency divisions of 2, 4, and 8 are available at the Q_1, Q_2, Q_3 outputs. Independent use of the first flip-flop is available if the reset function coincides with the reset of the 3-bit ripple-through counter.

Ordering Information

PART NUMBER	TEMP. RANGE (^{O}C)	PACKAGE	PKG. NO.
CD74HC93E	-55 to 125	14 Ld PDIP	E14.3
CD74HCT93E	-55 to 125	14 Ld PDIP	E14.3
CD74HC93M	-55 to 125	14 Ld SOIC	M14.15
CD74HCT93M	-55 to 125	14 Ld SOIC	M14.15

NOTES:

1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. 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.

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

File Number **1849.1**

TRUTH TABLE

COUNT	OUTPUTS			
	Q_0	Q_1	Q_2	Q_3
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H
10	L	H	L	H
11	H	H	L	H
12	L	L	H	H
13	H	L	H	H
14	L	H	H	H
15	H	H	H	H

NOTE: H = High Voltage Level, L = Low Voltage Level

MODE SELECTION

RESET OUTPUTS		OUTPUTS			
MR1	MR2	Q_0	Q_1	Q_2	Q_3
H	H	L	L	L	L
L	H	Count	Count	Count	Count
H	L				
L	L				

NOTE: H = High Voltage Level, L = Low Voltage Level

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 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} or I_{GND} . . . . . ±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
2V . . . . . 1000ns (Max)
4.5V. . . . . 500ns (Max)
6V . . . . . 400ns (Max)

Thermal Information

Thermal Resistance (Typical, Note 3)	θ_{JA} (°C/W)
PDIP Package	90
SOIC Package	175

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)

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:

3. 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			-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			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
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	µA

DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS V_I (V)	TEST CONDITIONS I_O (mA)	V_{CC} (V)	25°C MIN	25°C TYP	25°C MAX	-40°C TO 85°C MIN	-40°C TO 85°C MAX	-55°C TO 125°C MIN	-55°C TO 125°C MAX	UNITS
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} 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

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
$\overline{CP0}$, $\overline{CP1}$	0.6
MR1, MR2	0.4

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 MIN	25°C MAX	-40°C TO 85°C MIN	-40°C TO 85°C MAX	-55°C TO 125°C MIN	-55°C TO 125°C MAX	UNITS
HC TYPES									
Maximum Clock Frequency	f_{MAX}	2	6	-	5	-	4	-	MHz
		4.5	30	-	24	-	20	-	MHz
		6	35	-	28	-	24	-	MHz
Clock Pulse Width $\overline{CP0}$, $\overline{CP1}$	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	MAX	MIN	MAX	MIN	MAX	
Reset Pulse Width	t_W	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Reset Removal Time	t_{REM}	2	50	-	65	-	75	-	ns
		4.5	10	-	13	-	15	-	ns
		6	9	-	11	-	13	-	ns
HCT TYPES									
Maximum Clock Frequency	f_{MAX}	4.5	30	-	24	-	20	-	mHz
Clock Pulse Width $\overline{CP0}$, $\overline{CP1}$	t_W	4.5	16	-	20	-	24	-	ns
Reset Pulse Width	t_W	4.5	16	-	20	-	24	-	ns
Reset Removal Time	t_{REM}	4.5	10	-	13	-	15	-	ns

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 Time	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	-	125	-	155	-	190	ns
$\overline{CP0}$ to Q0		C_L = 50pF	4.5	-	-	25	-	31	-	38	ns
		C_L = 15pF	5	-	10		-	-	-	-	ns
		C_L = 50pF	6	-	-	21	-	26	-	32	ns
$\overline{CP1}$ to Q1	t_{PLH}, t_{PHL}	C_L = 50pF	2	-		135	-	170	-	205	ns
		C_L = 50pF	4.5	-		27	-	34	-	41	ns
		C_L = 50pF	6	-		23	-	29	-	35	ns
$\overline{CP1}$ to Q2	t_{PLH}, t_{PHL}	C_L = 50pF	2	-		185	-	230	-	280	ns
		C_L = 50pF	4.5	-		37	-	46	-	56	ns
		C_L = 50pF	6	-		31	-	39	-	48	ns
$\overline{CP1}$ to Q3	t_{PLH}, t_{PHL}	C_L = 50pF	2	-		245	-	305	-	370	ns
		C_L = 50pF	4.5	-		49	-	61	-	74	ns
		C_L = 15pF	5	-	21	-	-	-	-	-	ns
		C_L = 50pF	6	-	-	42	-	52	-	63	ns
MR1, MR2 to Qn	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
Output Transition Time	t_{TLH}, t_{THL}	C_L = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
			6	-	-	13	-	16	-	19	ns
Input Capacitance	C_{IN}	C_L = 50pF	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance	C_{PD}	-	-	-	25	-	-	10	-	19	pF

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	
HCT TYPES											
Propagation Delay Time	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	34	-	43	-	51	ns
$\overline{CP0}$ to Q0		C_L = 15pF	5	-	14	-	-	-	-	-	ns
$\overline{CP1}$ to Q1	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	34	-	43	-	51	ns
		C_L = 15pF	5	-	-	-	-	-	-	-	ns
$\overline{CP1}$ to Q2	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	46	-	58	-	69	ns
		C_L = 15pF	5	-	-	-	-	-	-	-	ns
$\overline{CP1}$ to Q3	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	58	-	73	-	87	ns
		C_L = 15pF	5	-	24	-	-	-	-	-	ns
MR1, MR2 to Qn	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	-	33	-	41	-	50	ns
		C_L = 15pF	5	-	13	-	-	-	-	-	ns
Output Transition Time	t_{TLH}, t_{THL}	C_L = 50pF	4.5	-	-	15	-	19	-	22	ns
Input Capacitance	C_{IN}	C_L = 50pF	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance	C_{PD}	-	-	-	-	25	-	-	-	-	pF

Test Circuits and Waveforms

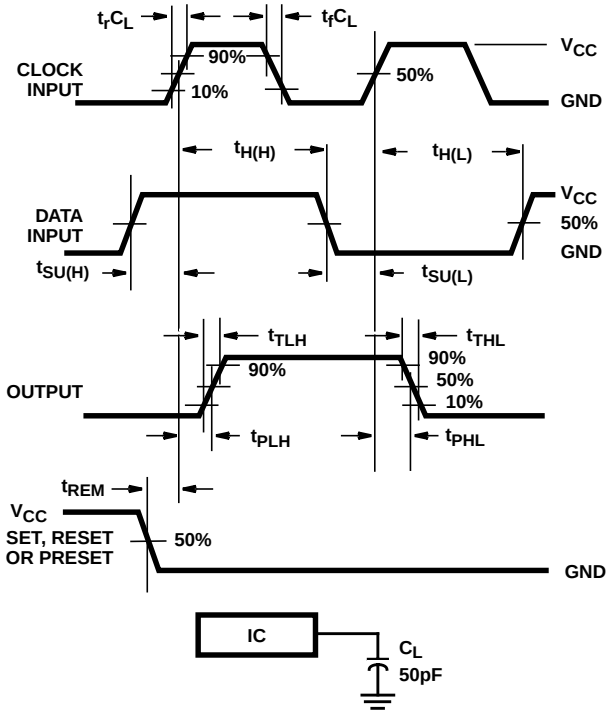


FIGURE 1. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

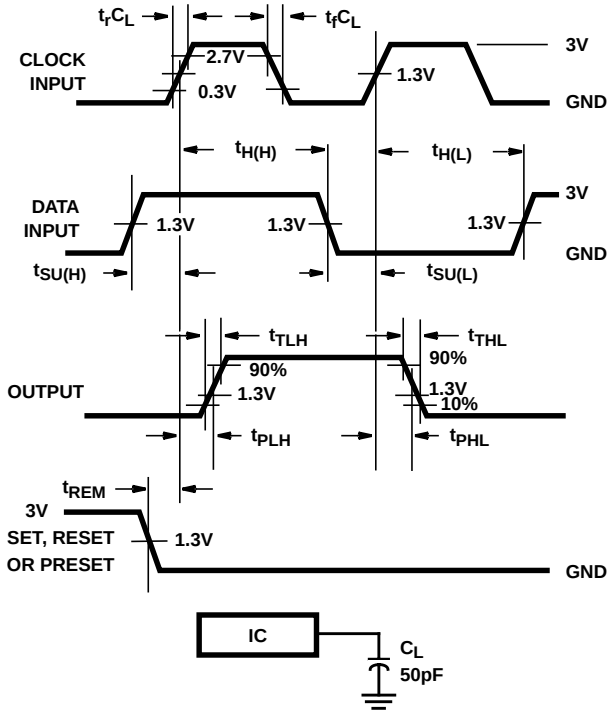


FIGURE 2. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

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