

CD74HC4020, CD74HCT4020

High Speed CMOS Logic 14-Stage Binary Counter

February 1998

Features

- Fully Static Operation
- Buffered Inputs
- Common Reset
- Negative Edge Clocking
- Typical $f_{MAX} = 60$ MHz at $V_{CC} = 5V$, $C_L = 15pF$, $T_A = 25^{\circ}C$
- 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

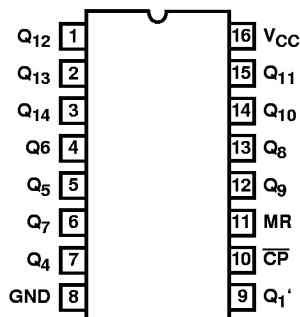
The Harris CD74HC4020 and CD74HCT4020 are 14-stage ripple-carry binary counters. All counter stages are master-slave flip-flops. The state of the stage advances one count on the negative clock transition of each input pulse; a high voltage level on the MR line resets all counters to their zero state. All inputs and outputs are buffered.

Ordering Information

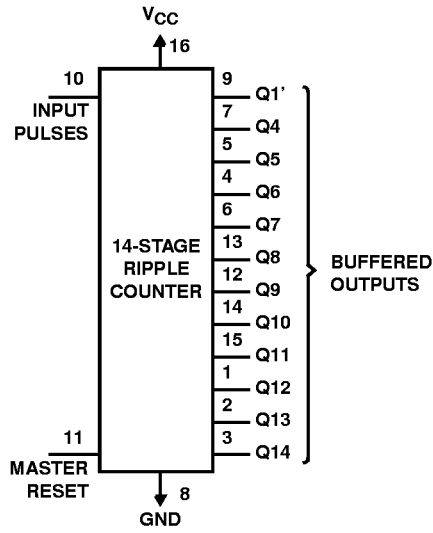
PART NUMBER	TEMP. RANGE ($^{\circ}C$)	PACKAGE	PKG. NO.
CD74HC4020E	-55 to 125	16 Ld PDIP	E16.3
CD74HCT4020E	-55 to 125	16 Ld PDIP	E16.3

Pinout

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(PDIP, SOIC)
TOP VIEW



Functional Diagram

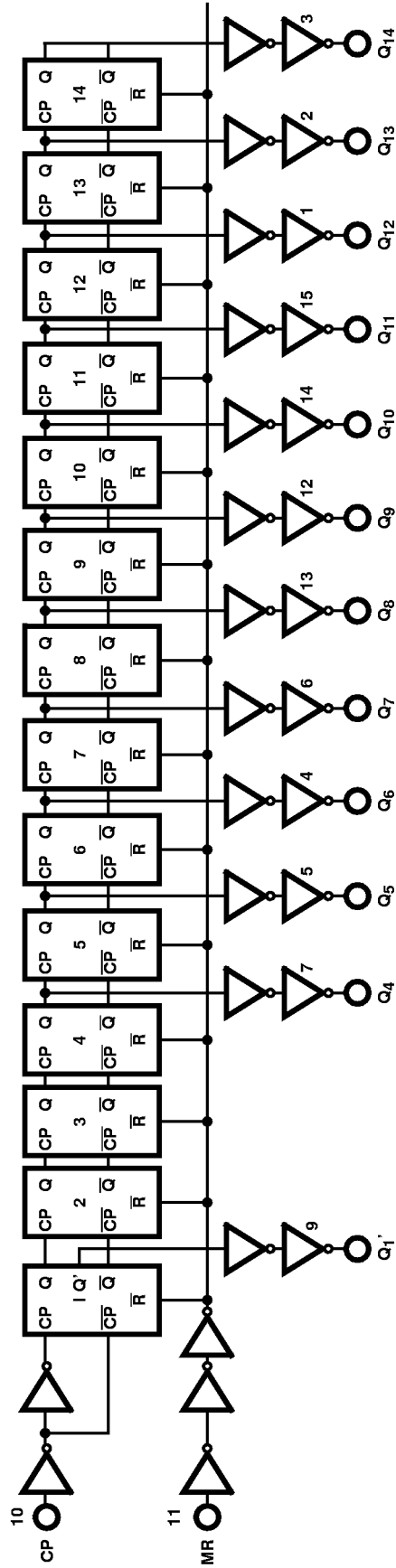


TRUTH TABLE

CP COUNT	MR	OUTPUT STATE
↑	L	No Change
↓	L	Advance to Next State
X	H	All Outputs Are Low

NOTE: H = High Voltage Level, L = Low Voltage Level, X = Don't Care,
 ↑ = Transition from Low to High Level, ↓ = Transition from High to Low.

Logic Diagram



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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 3)	θ_{JA} ($^{\circ}C/W$)
PDIP Package	90
SOIC Package	115
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 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:

- 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 $^{\circ}C$			-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	
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}	-	-	-	-	-	-	-	-	-	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
			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}	-	-	-	-	-	-	-	-	-	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
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	μA

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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	
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	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	ΔI _{CC}	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
MR	0.65
CP	0.5

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

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 Input Pulse Frequency	f _{MAX}	2	6	-	5	-	4	-	ns
		4.5	30	-	25	-	20	-	ns
		6	35	-	29	-	24	-	ns
Input 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

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Prerequisite for Switching Specifications (Continued)

PARAMETER	SYMBOL	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
HCT TYPES									
Maximum Input Pulse Frequency	f _{MAX}	4.5	25	-	20	-	16	-	MHz
Input Pulse Width	t _W	4.5	20	-	25	-	30	-	ns
Reset Recovery Time	t _{REC}	4.5	10	-	13	-	15	-	ns
Reset Pulse Width	t _W	4.5	20	-	25	-	30	-	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 (Figure 1) CP to Q1' Output	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	140	-	175	-	210	ns
			4.5	-	-	28	-	35	-	42	ns
		C _L = 15pF	5	-	11	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	24	-	30	-	36	ns
Q _n to Q _n + 1	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	75	-	95	-	110	ns
			4.5	-	-	15	-	19	-	22	ns
		C _L = 15pF	5	-	6	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	13	-	16	-	19	ns
MR to Q _n	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	-	170	-	215	-	255	ns
			4.5	-	-	34	-	43	-	51	ns
			5	-	14	-	-	-	-	-	ns
			6	-	-	29	-	37	-	43	ns
Output Transition Time (Figure 1)	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 (Notes 4, 5)	C _{PD}	C _L = 15pF	5	-	30	-	-	-	-	-	pF
HCT TYPES											
Propagation Delay Time (Figure 2) CP to Q1' Output	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	40	-	50	-	60	ns
		C _L = 15pF	5	-	17	-	-	-	-	-	ns
Q _n to Q _n + 1	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	15	-	19	-	22	ns
		C _L = 15pF	5	-	6	-	-	-	-	-	ns
MR to Q _n	t _{PLH} , t _{PHL}	C _L = 50pF	4.5	-	-	40	-	50	-	60	ns
		C _L = 15pF	5	-	17	-	-	-	-	-	ns

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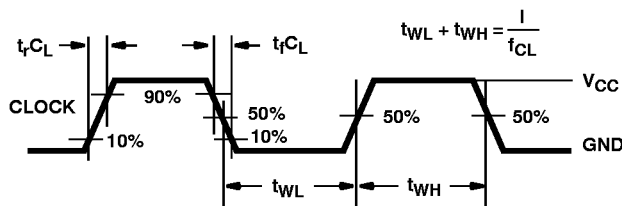
Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

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	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	-	15	-	19	-	22	ns
Input Capacitance	C_{IN}	$C_L = 15\text{pF}$	-	-	-	10	-	10	-	10	pF
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	$C_L = 15\text{pF}$	5	-	30	-	-	-	-	-	pF

NOTES:

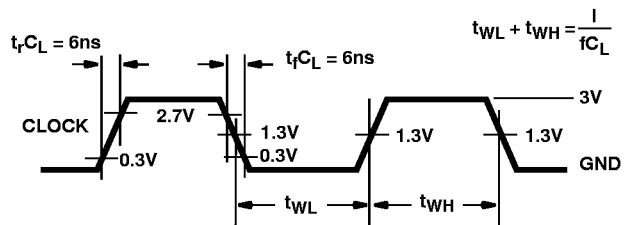
4. C_{PD} is used to determine the dynamic power consumption, per package.
5. $P_D = V_{CC}^2 f_i (C_{PD} + C_L)$ where f_i = Input Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

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