



## MM54HC4020/MM74HC4020 14-Stage Binary Counter

## MM54HC4040/MM74HC4040 12-Stage Binary Counter

### General Description

The MM54HC4020/MM74HC4020, MM54HC4040/MM74HC4040, are high speed binary ripple carry counters. These counters are implemented utilizing advanced silicon-gate CMOS technology to achieve speed performance similar to LS-TTL logic while retaining the low power and high noise immunity of CMOS.

The 'HC4020 is a 14 stage counter and the 'HC4040 is a 12-stage counter. Both devices are incremented on the falling edge (negative transition) of the input clock, and all their outputs are reset to a low level by applying a logical high on their reset input.

These devices are pin equivalent to the CD4020 and CD4040 respectively. All inputs are protected from damage due to static discharge by protection diodes to  $V_{CC}$  and ground.

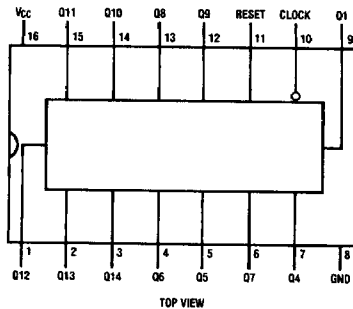
### Features

- Typical propagation delay: 16 ns
- Wide operating voltage range: 2–6V
- Low input current: 1  $\mu$ A maximum
- Low quiescent current: 80  $\mu$ A maximum (74HC Series)
- Output drive capability: 10 LS-TTL loads

### Connection Diagrams

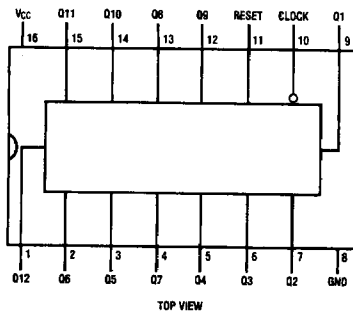
#### Dual-In-Line Packages

##### 'HC4040



TL/F/5216-1

##### 'HC4020



TL/F/5216-3

Order Number MM54HC4020/4040\* or MM74HC4020/4040\*

\*Please look into Section 8, Appendix D for availability of various package types.

**Absolute Maximum Ratings** (Notes 1 & 2)

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ( $V_{CC}$ )	-0.5 to +7.0V
DC Input Voltage ( $V_{IN}$ )	-1.5 to $V_{CC} + 1.5V$
DC Output Voltage ( $V_{OUT}$ )	-0.5 to $V_{CC} + 0.5V$
Clamp Diode Current ( $I_{CD}$ )	$\pm 20$ mA
DC Output Current, per pin ( $I_{OUT}$ )	$\pm 25$ mA
DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ )	$\pm 50$ mA
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C
Power Dissipation ( $P_D$ )	
(Note 3)	600 mW
S.O. Package only	500 mW
Lead Temperature ( $T_L$ )	
(Soldering 10 seconds)	260°C

**Operating Conditions**

	Min	Max	Units
Supply Voltage ( $V_{CC}$ )	2	6	V
DC Input or Output Voltage ( $V_{IN}, V_{OUT}$ )	0	$V_{CC}$	V
Operating Temp. Range ( $T_A$ )			
MM74HC	-40	+85	°C
MM54HC	-55	+125	°C
Input Rise or Fall Times ( $t_r, t_f$ )			
$V_{CC} = 2.0V$		1000	ns
$V_{CC} = 4.5V$		500	ns
$V_{CC} = 6.0V$		400	ns

**DC Electrical Characteristics** (Note 4)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$			Units	
				74HC $T_A = -40$ to $85^\circ C$		54HC $T_A = -55$ to $125^\circ C$		
				Typ	Guaranteed Limits			
$V_{IH}$	Minimum High Level Input Voltage		2.0V	1.5	1.5	1.5	V	
			4.5V	3.15	3.15	3.15	V	
			6.0V	4.2	4.2	4.2	V	
$V_{IL}$	Maximum Low Level Input Voltage**		2.0V	0.5	0.5	0.5	V	
			4.5V	1.35	1.35	1.35	V	
			6.0V	1.8	1.8	1.8	V	
$V_{OH}$	Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu A$	2.0V	2.0	1.9	1.9	V	
			4.5V	4.5	4.4	4.4	V	
			6.0V	6.0	5.9	5.9	V	
		$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 4.0$ mA $ I_{OUT}  \leq 5.2$ mA	4.5V	4.2	3.98	3.84	3.7	V
			6.0V	5.7	5.48	5.34	5.2	V
$V_{OL}$	Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 20 \mu A$	2.0V	0	0.1	0.1	0.1	V
			4.5V	0	0.1	0.1	0.1	V
			6.0V	0	0.1	0.1	0.1	V
		$V_{IN} = V_{IH}$ or $V_{IL}$ $ I_{OUT}  \leq 4.0$ mA $ I_{OUT}  \leq 5.2$ mA	4.5V	0.2	.26	0.33	0.4	V
			6.0V	0.2	.26	0.33	0.4	V
$I_{IN}$	Maximum Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		$\pm 0.1$	$\pm 1.0$	$\mu A$	
$I_{CC}$	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0 \mu A$	6.0V		8.0	80	160	$\mu A$

**Note 1:** Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: -12 mW/°C from 65°C to 85°C; ceramic "J" package: -12 mW/°C from 100°C to 125°C.

**Note 4:** For a power supply of 5V  $\pm 10\%$  the worst case output voltages ( $V_{OH}$ , and  $V_{OL}$ ) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case  $V_{IH}$  and  $V_{IL}$  occur at  $V_{CC} = 5.5V$  and 4.5V respectively. (The  $V_{IH}$  value at 5.5V is 3.85V.) The worst case leakage current ( $I_{IN}$ ,  $I_{CC}$ , and  $I_{OZ}$ ) occur for CMOS at the higher voltage and so the 6.0V values should be used.

\*\* $V_{IL}$  limits are currently tested at 20% of  $V_{CC}$ . The above  $V_{IL}$  specification (30% of  $V_{CC}$ ) will be implemented no later than Q1, CY'89.

**AC Electrical Characteristics**  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$ ,  $C_L = 15 pF$ ,  $t_r = t_f = 6 ns$ 

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
$f_{MAX}$	Maximum Operating Frequency		50	30	MHz
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Clock to Q	(Note 5)	17	35	ns
$t_{PHL}$	Maximum Propagation Delay Reset to any Q		16	40	ns
$t_{REM}$	Minimum Reset Removal Time		10	20	ns
$t_W$	Minimum Pulse Width		10	16	ns

**AC Electrical Characteristics**  $V_{CC} = 2.0V$  to  $6.0V$ ,  $C_L = 50 pF$ ,  $t_r = t_f = 6 ns$  (unless otherwise specified)

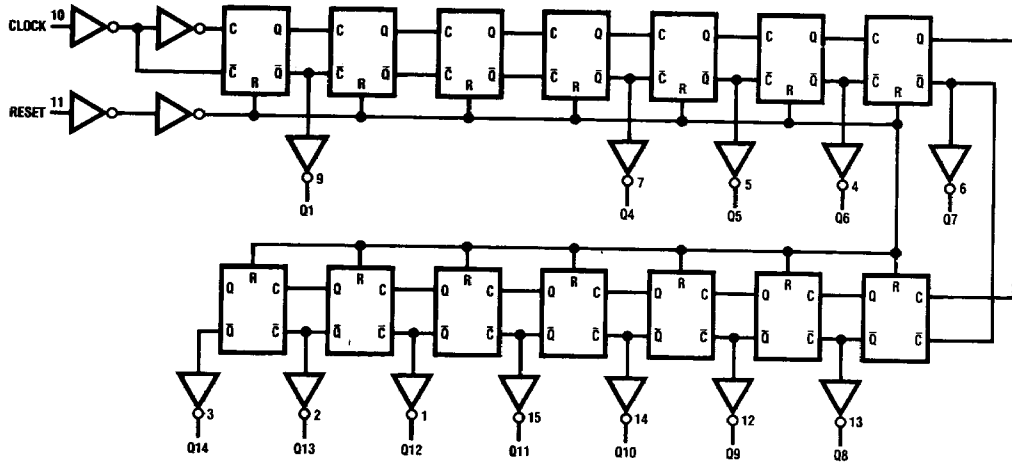
Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^\circ C$		$T_A = -40$ to $85^\circ C$		$T_A = -55$ to $125^\circ C$		Units
				Typ	Guaranteed Limits					
$f_{MAX}$	Maximum Operating Frequency		2.0V	10	6	5		4		MHz
			4.5V	40	30	24		20		
			6.0V	50	35	28		24		
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Clock to $Q_1$		2.0V	80	210	265		313		ns
			4.5V	21	42	53		63		
			6.0V	18	36	45		53		
$T_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Between Stages from $Q_n$ to $Q_{n+1}$		2.0V	80	125	156		188		ns
			4.5V	18	25	31		38		
			6.0V	15	21	26		31		
$t_{PHL}$	Maximum Propagation Delay Reset to Q ('4024 only)		2.0V	80	210	265		313		ns
			4.5V	21	42	53		63		
			6.0V	18	36	45		53		
$t_{PHL}$	Maximum Propagation Delay Reset to any Q ('4020 and '4040)		2.0V	72	240	302		358		ns
			4.5V	24	48	60		72		
			6.0V	20	41	51		61		
$t_{REM}$	Minimum Reset Removal Time		2.0V		100	126		149		ns
			4.5V		20	25		50		
			6.0V		16	21		25		
$t_W$	Minimum Pulse Width		2.0V		90	100		120		ns
			4.5V		16	20		24		
			6.0V		14	18		20		
$t_{TLH}$ , $t_{THL}$	Maximum Output Rise and Fall Time		2.0V	30	75	95		110		ns
			4.5V	10	15	19		22		
			6.0V	9	13	16		19		
$t_r$ , $t_f$	Maximum Input Rise and Fall Time				1000	1000		1000		ns
					500	500		500		
					400	400		400		
$C_{PD}$	Power Dissipation Capacitance (Note 6)	(per package)		55					pF	
$C_{IN}$	Maximum Input Capacitance			5	10	10		10		pF

**Note 5:** Typical Propagation delay time to any output can be calculated using:  $t_p = 17 + 12(N-1)$  ns; where N is the number of the output,  $Q_W$ , at  $V_{CC} = 5V$ .

**Note 6:**  $C_{PD}$  determines the no load dynamic power consumption,  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ , and the no load dynamic current consumption,  $I_S = C_{PD} V_{CC} f + I_{CC}$ .

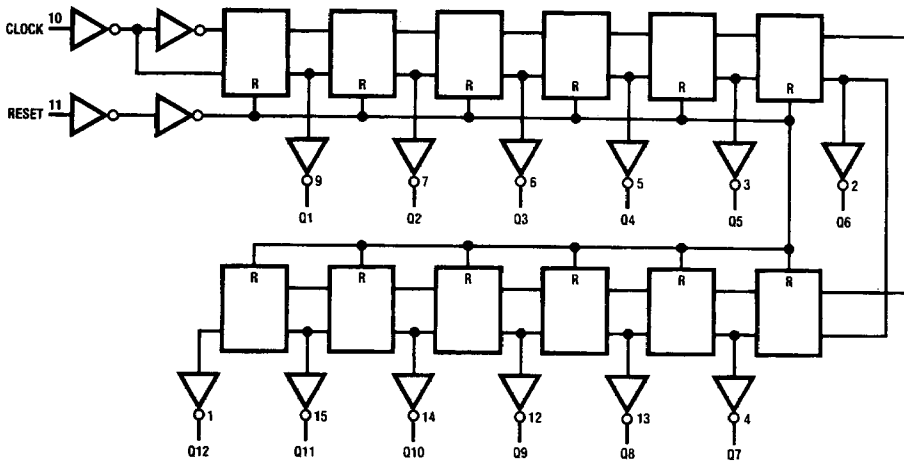
# Logic Diagrams

MM54HC4020/MM74HC4020



TL/F/5216-5

MM54HC4040/MM74HC4040

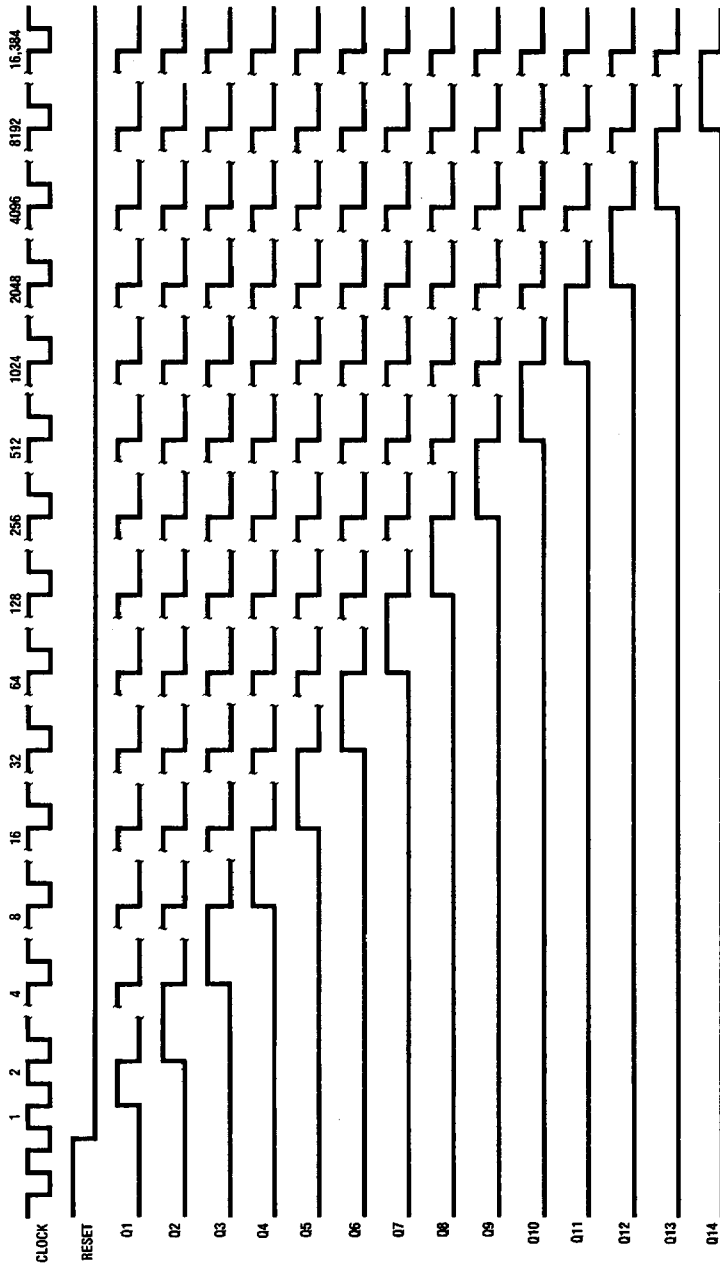


TL/F/5216-7

MM54HC4020/MM74HC4020/MM54HC4040/MM74HC4040

3

# Timing Diagram



TL/F/5216-11