

MC14020B

14-Bit Binary Counter

The MC14020B 14-stage binary counter is constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. This part is designed with an input wave shaping circuit and 14 stages of ripple-carry binary counter. The device advances the count on the negative-going edge of the clock pulse. Applications include time delay circuits, counter controls, and frequency-dividing circuits.

- Fully Static Operation
- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load Over the Rated Temperature Range
- Buffered Outputs Available from stages 1 and 4 thru 14
- Common Reset Line
- Pin-for-Pin Replacement for CD4020B

MAXIMUM RATINGS (Voltages Referenced to V_{SS}) (Note 2.)

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage Range	-0.5 to +18.0	V
V_{in}, V_{out}	Input or Output Voltage Range (DC or Transient)	-0.5 to $V_{DD} + 0.5$	V
I_{in}, I_{out}	Input or Output Current (DC or Transient) per Pin	± 10	mA
P_D	Power Dissipation, per Package (Note 3.)	500	mW
T_A	Ambient Temperature Range	-55 to +125	$^{\circ}C$
T_{stg}	Storage Temperature Range	-65 to +150	$^{\circ}C$
T_L	Lead Temperature (8-Second Soldering)	260	$^{\circ}C$

- Maximum Ratings are those values beyond which damage to the device may occur.
- Temperature Derating:
Plastic "P and D/DW" Packages: -7.0 mW/ $^{\circ}C$ From 65 $^{\circ}C$ To 125 $^{\circ}C$

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$.

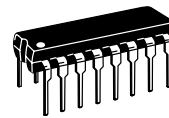
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.



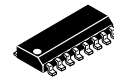
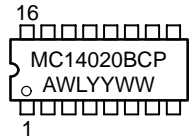
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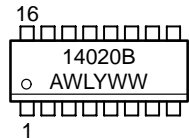
MARKING DIAGRAMS



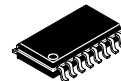
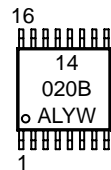
PDIP-16
P SUFFIX
CASE 648



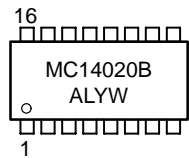
SOIC-16
D SUFFIX
CASE 751B



TSSOP-16
DT SUFFIX
CASE 948F



SOEIAJ-16
F SUFFIX
CASE 966



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

ORDERING INFORMATION

Device	Package	Shipping
MC14020BCP	PDIP-16	2000/Box
MC14020BD	SOIC-16	48/Rail
MC14020BDR2	SOIC-16	2500/Tape & Reel
MC14020BDT	TSSOP-16	96/Rail
MC14020BF	SOEIAJ-16	See Note 1.
MC14020BFEL	SOEIAJ-16	See Note 1.



- For ordering information on the EIAJ version of the SOIC packages, please contact your local ON Semiconductor representative.

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PIN ASSIGNMENT

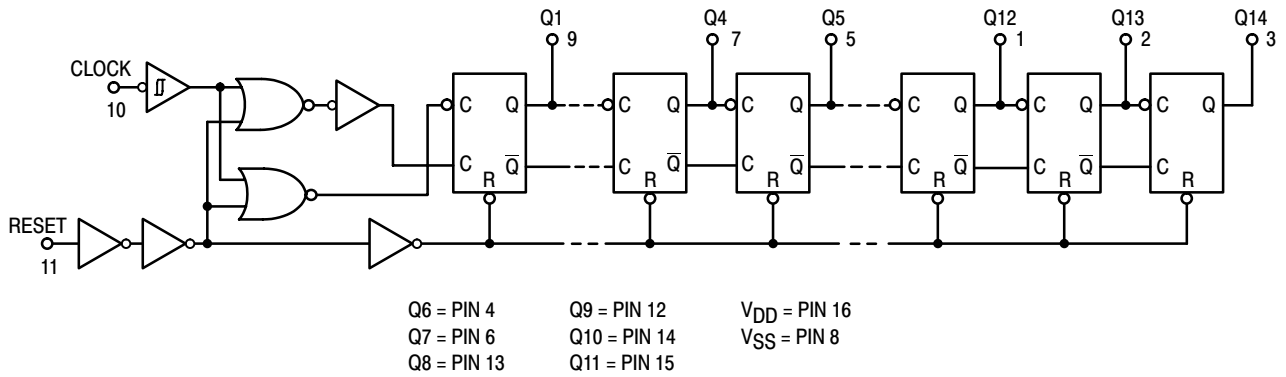
Q12	1	16	V _{DD}
Q13	2	15	Q11
Q14	3	14	Q10
Q6	4	13	Q8
Q5	5	12	Q9
Q7	6	11	R
Q4	7	10	C
V _{SS}	8	9	Q1

TRUTH TABLE

Clock	Reset	Output State
	0	No Change
	0	Advance to Next State
X	1	All Outputs are Low

X = Don't Care

LOGIC DIAGRAM



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ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V _{DD} Vdc	- 55°C		25°C			125°C		Unit	
			Min	Max	Min	Typ (4.)	Max	Min	Max		
Output Voltage V _{in} = V _{DD} or 0	V _{OL}	5.0	—	0.05	—	0	0.05	—	0.05	Vdc	
		10	—	0.05	—	0	0.05	—	0.05		
15		—	0.05	—	0	0.05	—	0.05	—		
V _{in} = 0 or V _{DD}	V _{OH}	5.0	4.95	—	4.95	5.0	—	4.95	—	Vdc	
		10	9.95	—	9.95	10	—	9.95	—		
		15	14.95	—	14.95	15	—	14.95	—		
Input Voltage (V _O = 4.5 or 0.5 Vdc) (V _O = 9.0 or 1.0 Vdc) (V _O = 13.5 or 1.5 Vdc)	V _{IL}	5.0	—	1.5	—	2.25	1.5	—	1.5	Vdc	
		10	—	3.0	—	4.50	3.0	—	3.0		
		15	—	4.0	—	6.75	4.0	—	4.0		
	V _{in} = 0 or V _{DD}	V _{IH}	5.0	3.5	—	3.5	2.75	—	3.5	—	Vdc
			10	7.0	—	7.0	5.50	—	7.0	—	
			15	11	—	11	8.25	—	11	—	
Output Drive Current (V _{OH} = 2.5 Vdc) (V _{OH} = 4.6 Vdc) (V _{OH} = 9.5 Vdc) (V _{OH} = 13.5 Vdc)	Source	I _{OH}	5.0	-3.0	—	-2.4	-4.2	—	-1.7	—	mAdc
		5.0	-0.64	—	-0.51	-0.88	—	-0.36	—		
		10	-1.6	—	-1.3	-2.25	—	-0.9	—		
		15	-4.2	—	-3.4	-8.8	—	-2.4	—		
	Sink	I _{OL}	5.0	0.64	—	0.51	0.88	—	0.36	—	mAdc
			10	1.6	—	1.3	2.25	—	0.9	—	
15	4.2	—	3.4	8.8	—	2.4	—	—			
Input Current	I _{in}	15	—	± 0.1	—	± 0.00001	± 0.1	—	± 1.0	μAdc	
Input Capacitance (V _{in} = 0)	C _{in}	—	—	—	—	5.0	7.5	—	—	pF	
Quiescent Current (Per Package)	I _{DD}	5.0	—	5.0	—	0.005	5.0	—	150	μAdc	
		10	—	10	—	0.010	10	—	300		
		15	—	20	—	0.015	20	—	600		
Total Supply Current (5.) (6.) (Dynamic plus Quiescent, Per Package) (C _L = 50 pF on all outputs, all buffers switching)	I _T	5.0 10 15	I _T = (0.42 μA/kHz)f + I _{DD} I _T = (0.85 μA/kHz)f + I _{DD} I _T = (1.43 μA/kHz)f + I _{DD}							μAdc	

4. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

5. The formulas given are for the typical characteristics only at 25°C.

6. To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) Vfk$$

where: I_T is in μA (per package), C_L in pF, V = (V_{DD} - V_{SS}) in volts, f in kHz is input frequency, and k = 0.001.

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SWITCHING CHARACTERISTICS (7.) ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$)

Characteristic	Symbol	V_{DD} Vdc	Min	Typ (8.)	Max	Unit
Output Rise and Fall Time t_{TLH} , $t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ t_{TLH} , $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ t_{TLH} , $t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$	t_{TLH} , t_{THL}	5.0 10 15	— — —	100 50 40	200 100 80	ns
Propagation Delay Time Clock to Q1 t_{PHL} , $t_{PLH} = (1.7 \text{ ns/pF}) C_L + 175 \text{ ns}$ t_{PHL} , $t_{PLH} = (0.66 \text{ ns/pF}) C_L + 82 \text{ ns}$ t_{PHL} , $t_{PLH} = (0.5 \text{ ns/pF}) C_L + 55 \text{ ns}$	t_{PLH} , t_{PHL}	5.0 10 15	— — —	260 115 80	520 230 160	ns
Clock to Q14 t_{PHL} , $t_{PLH} = (1.7 \text{ ns/pF}) C_L + 1735 \text{ ns}$ t_{PHL} , $t_{PLH} = (0.66 \text{ ns/pF}) C_L + 772 \text{ ns}$ t_{PHL} , $t_{PLH} = (0.5 \text{ ns/pF}) C_L + 535 \text{ ns}$		5.0 10 15	— — —	1820 805 560	3900 1725 1200	ns
Propagation Delay Time Reset to Q_n $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 285 \text{ ns}$ $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 122 \text{ ns}$ $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 90 \text{ ns}$	t_{PHL}	5.0 10 15	— — —	370 155 115	740 310 230	ns
Clock Pulse Width	t_{WH}	5.0 10 15	500 165 125	140 55 38	— — —	ns
Clock Pulse Frequency	f_{cl}	5.0 10 15	— — —	2.0 6.0 8.0	1.0 3.0 4.0	MHz
Clock Rise and Fall Time	t_{TLH} , t_{THL}	5.0 10 15	No Limit			—
Reset Pulse Width	t_{WL}	5.0 10 15	3000 550 420	320 120 80	— — —	ns
Reset Removal Time	t_{rem}	5.0 10 15	130 50 30	65 25 15	— — —	ns

7. The formulas given are for the typical characteristics only at 25°C.

8. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

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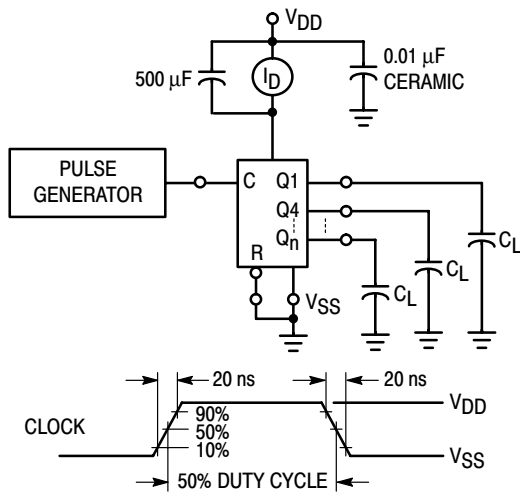


Figure 1. Power Dissipation Test Circuit and Waveform

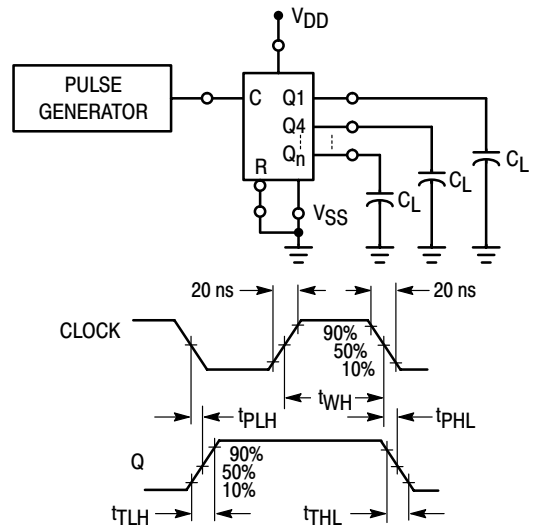


Figure 2. Switching Time Test Circuit and Waveforms

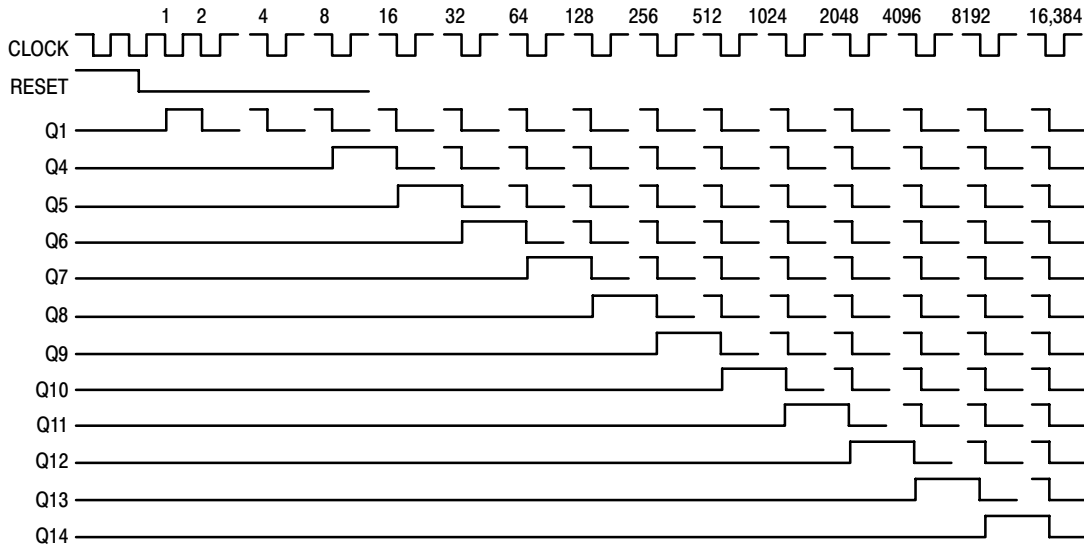


Figure 3. Timing Diagram