



MOTOROLA

PRESETTABLE 4-BIT DOWN COUNTERS

The MC14522B BCD counter and the MC14526B binary counter are constructed with MOS P-channel and N-channel enhancement mode devices in a monolithic structure.

These devices are presettable, cascadable, synchronous down counters with a decoded "0" state output for divide-by-N applications. In single stage applications the "0" output is applied to the Preset Enable input. The Cascade Feedback input allows cascade divide-by-N operation with no additional gates required. The Inhibit input allows disabling of the pulse counting function. Inhibit may also be used as a negative edge clock.

These complementary MOS counters can be used in frequency synthesizers, phase-locked loops, and other frequency division applications requiring low power dissipation and/or high noise immunity.

- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Logic Edge-Clocked Design — Incremented on Positive Transition of Clock or Negative Transition of Inhibit
- Asynchronous Preset Enable
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load Over the Rated Temperature Range

MAXIMUM RATINGS* (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V _{DD}	DC Supply Voltage	-0.5 to +18.0	V
V _{in} , V _{out}	Input or Output Voltage (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†	500	mW
T _{stg}	Storage Temperature	-65 to +150	°C
T _L	Lead Temperature (8-Second Soldering)	260	°C

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

†Temperature Derating: Plastic "P" Package: -12mW/°C from 65°C to 85°C

Ceramic "L" Package: -12mW/°C from 100°C to 125°C

FUNCTION TABLE

Inputs					Output	Resulting Function
Clock	Reset	Inhibit	Preset Enable	Cascade Feedback	"0"	
X	H	X	L	L	L	Asynchronous reset*
X	H	X	H	L	H	Asynchronous reset
X	H	X	X	H	H	Asynchronous reset
X	L	X	H	X	L	Asynchronous preset
	L	H	L	X	L	Decrement inhibited
	L	L	L	X	L	Decrement inhibited
	L	L	L	L	L	No change** (inactive edge)
	L	L	L	L	L	No change** (inactive edge)
	L	L	L	L	L	Decrement**
	L	L	L	L	L	Decrement**

X = Don't Care

Notes:

* Output "0" is low when reset goes high only if PE and CF are low.

** Output "0" is high when reset is low, only if CF is high and count is 0000.

MC14522B MC14526B

CMOS MSI

(LOW-POWER COMPLEMENTARY MOS)

PRESETTABLE 4-BIT DOWN COUNTERS

BCD — MC14522B

Binary — MC14526B



L SUFFIX
CERAMIC PACKAGE
CASE 620



P SUFFIX
PLASTIC PACKAGE
CASE 648

ORDERING INFORMATION

A Series: -55°C to +125°C

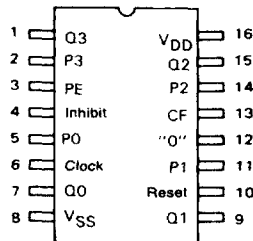
MC14XXBAL (Ceramic Package Only)

C Series: -40°C to +85°C

MC14XXBCP (Plastic Package)

MC14XXBCL (Ceramic Package)

PIN ASSIGNMENT



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} ≤ (V_{in} or V_{out}) ≤ 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.

MC14522B•MC14526B

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V _{DD} Vdc	T _{low} *		25°C			T _{high} *		Unit
			Min	Max	Min	Typ #	Max	Min	Max	
Output Voltage V _{in} = V _{DD} or 0	"0" Level VOL	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	
	"1" Level VOH	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)	"0" Level VIL	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	
	"1" Level VIH	5.0	3.5	—	3.5	2.75	—	3.5	—	Vdc
		10	7.0	—	7.0	5.50	—	7.0	—	
		15	11.0	—	11.0	8.25	—	11.0	—	
Output Drive Current (AL Device)	Source (VOH = 2.5 Vdc) (VOH = 4.6 Vdc) (VOH = 9.5 Vdc) (VOH = 13.5 Vdc)	I _{OH}	5.0	-3.0	—	-2.4	-4.2	—	-1.7	mA _{dc}
			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	
			15	-4.2	—	-3.4	-8.8	—	-2.4	
	Sink (VOL = 0.4 Vdc) (VOL = 0.5 Vdc) (VOL = 1.5 Vdc)	I _{OL}	5.0	0.64	—	0.51	0.88	—	0.36	mA _{dc}
			10	1.6	—	1.3	2.25	—	0.9	
			15	4.2	—	3.4	8.8	—	2.4	
			15	4.2	—	3.4	8.8	—	2.4	
			15	4.2	—	3.4	8.8	—	2.4	
Output Drive Current (CL/CP Device)	Source (VOH = 2.5 Vdc) (VOH = 4.6 Vdc) (VOH = 9.5 Vdc) (VOH = 13.5 Vdc)	I _{OH}	5.0	-2.5	—	-2.1	-4.2	—	-1.7	mA _{dc}
			5.0	-0.52	—	-0.44	-0.88	—	-0.36	
			10	-1.3	—	-1.1	-2.25	—	-0.9	
			15	-3.6	—	-3.0	-8.8	—	-2.4	
			15	-3.6	—	-3.0	-8.8	—	-2.4	
	Sink (VOL = 0.4 Vdc) (VOL = 0.5 Vdc) (VOL = 1.5 Vdc)	I _{OL}	5.0	0.52	—	0.44	0.88	—	0.36	mA _{dc}
			10	1.3	—	1.1	2.25	—	0.9	
			15	3.6	—	3.0	8.8	—	2.4	
			15	3.6	—	3.0	8.8	—	2.4	
			15	3.6	—	3.0	8.8	—	2.4	
Input Current (AL Device)	I _{in}	15	—	±0.1	—	±0.00001	±0.1	—	±1.0	μA _{dc}
Input Current (CL/CP Device)	I _{in}	15	—	±0.3	—	±0.00001	±0.3	—	±1.0	μA _{dc}
Input Capacitance (V _{in} = 0)	C _{in}	—	—	—	—	5.0	7.5	—	—	pF
Quiescent Current (AL Device) (Per Package)	I _{DD}	5.0	—	5.0	—	0.005	5.0	—	150	μA _{dc}
		10	—	10	—	0.010	10	—	300	
		15	—	20	—	0.015	20	—	600	
Quiescent Current (CL/CP Device) (Per Package)	I _{DD}	5.0	—	20	—	0.005	20	—	150	μA _{dc}
		10	—	40	—	0.010	40	—	300	
		15	—	80	—	0.015	80	—	600	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) (C _L = 50 pF on all outputs, all buffers switching)	I _T	5.0	I _T = (1.7 μA/kHz) f + I _{DD} I _T = (3.4 μA/kHz) f + I _{DD} I _T = (5.1 μA/kHz) f + I _{DD}							μA _{dc}

*T_{low} = -55°C for AL Device, -40°C for CL/CP Device.
T_{high} = +125°C for AL Device, +85°C for CL/CP Device.

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

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) V f k$$

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

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.

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

MC14522B•MC14526B

SWITCHING CHARACTERISTICS* ($C_L = 60$ pF, $T_A = 25^\circ\text{C}$)

Characteristic	Symbol	V _{DD}	Min	Typ #	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} (Figures 4, 5)	5.0 10 15	— — —	100 50 40	200 100 80	ns
Propagation Delay Time (Inhibit Used as Negative-Edge Clock) Clock or Inhibit to Q $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 465 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 197 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 135 \text{ ns}$ Clock or Inhibit to "0" $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 155 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 87 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 65 \text{ ns}$	$t_{PLH},$ t_{PHL} (Figures 4, 5, 6)	5.0 10 15 5.0 10 15	— — — — — —	550 225 160 240 130 100	1100 450 320 480 260 200	ns
Propagation Delay Time Pn to Q	$t_{PLH},$ t_{PHL} (Figures 4, 7)	5.0 10 15	— — —	260 120 100	520 240 200	ns
Propagation Delay Time Reset to Q	t_{PHL} (Figure 8)	5.0 10 15	— — —	250 110 80	500 220 160	ns
Propagation Delay Time Preset Enable to "0"	$t_{PHL},$ t_{PLH} (Figures 4, 9)	5.0 10 15	— — —	220 100 80	440 200 160	ns
Clock or Inhibit Pulse Width	t_w (Figures 5, 6)	5.0 10 15	250 100 80	125 50 40	— — —	ns
Clock Pulse Frequency (with PE = low)	f_{max} (Figures 4, 5, 6)	5.0 10 15	— — —	2.0 5.0 6.6	1.5 3.0 4.0	MHz
Clock or Inhibit Rise and Fall Time	$t_r,$ t_f (Figures 5, 6)	5.0 10 15	— — —	— — —	15 5 4	μs
Setup Time Pn to Preset Enable	t_{su} (Figure 10)	5.0 10 15	90 50 40	40 15 10	— — —	ns
Hold Time Preset Enable to Pn	t_h (Figure 10)	5.0 10 15	30 30 30	-15 -5 0	— — —	ns
Preset Enable Pulse Width	t_w (Figure 10)	5.0 10 15	250 100 80	125 50 40	— — —	ns
Reset Pulse Width	t_w (Figure 8)	5.0 10 15	350 250 200	175 125 100	— — —	ns
Reset Removal Time	t_{rem} (Figure 8)	5.0 10 15	10 20 30	-110 -30 -20	— — —	ns

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

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

MC14522B•MC14526B

FIGURE 1 – TYPICAL OUTPUT SOURCE CHARACTERISTICS TEST CIRCUIT

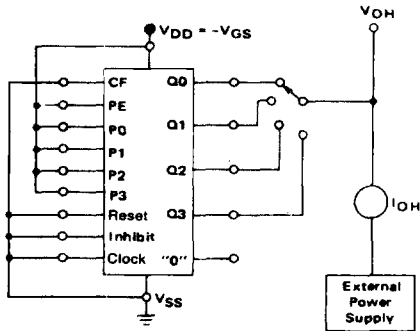


FIGURE 2 – TYPICAL OUTPUT SINK CHARACTERISTICS TEST CIRCUIT

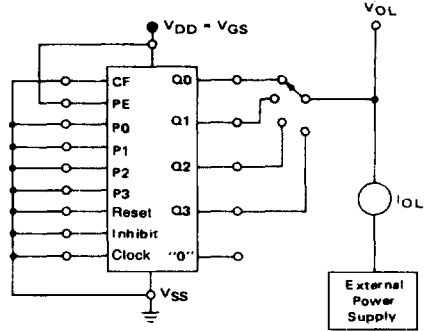


FIGURE 3 – POWER DISSIPATION

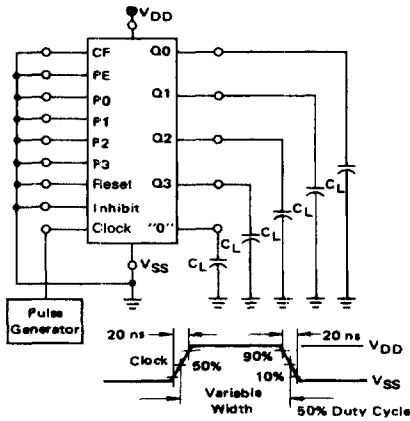
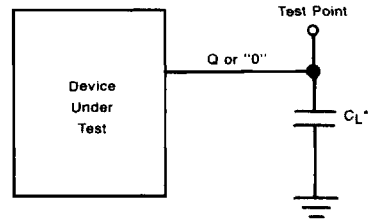


FIGURE 4 – TEST CIRCUIT



*Includes all probe and jig capacitance.

SWITCHING WAVEFORMS

FIGURE 5

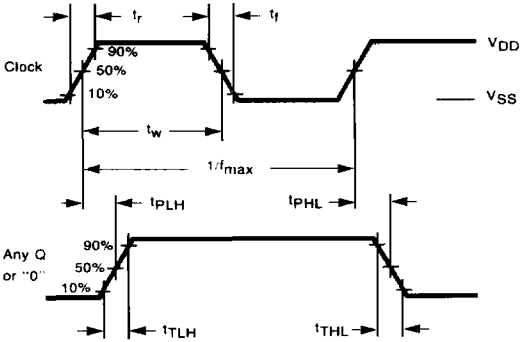


FIGURE 6

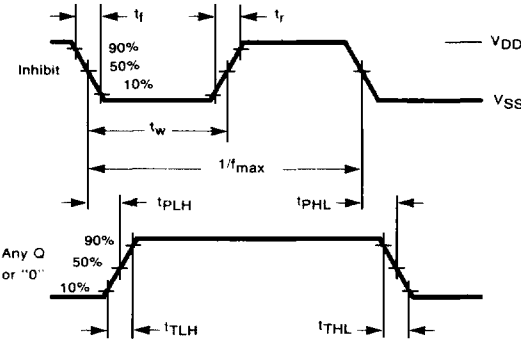


FIGURE 7

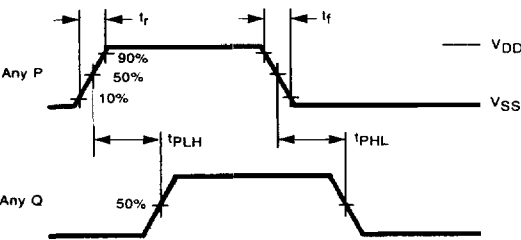


FIGURE 8

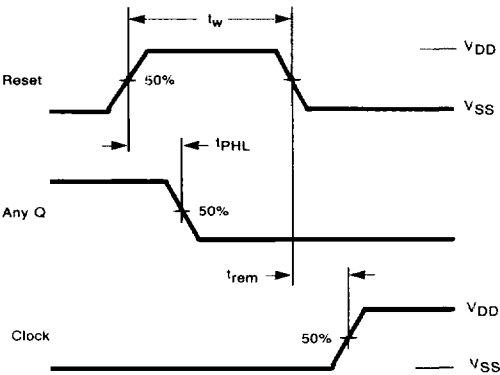


FIGURE 9

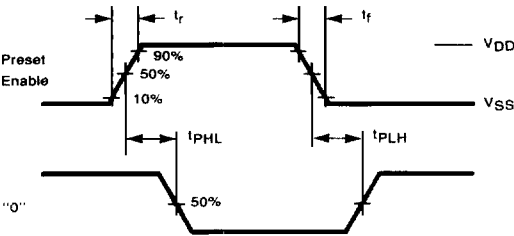
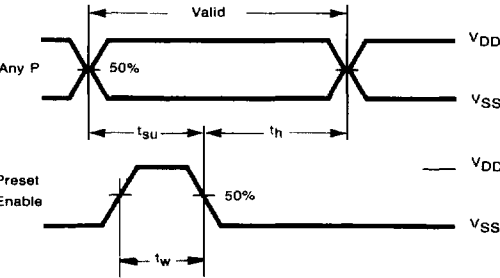


FIGURE 10



MC14522B•MC14526B

PIN DESCRIPTIONS

Preset Enable (Pin 3) — If Reset is low, a high level on the Preset Enable input asynchronously loads the counter with the programmed values on P0, P1, P2, and P3.

Inhibit (Pin 4) — A high level on the Inhibit input prevents the Clock from decrementing the counter. With Clock (pin 6) held high, Inhibit may be used as a negative edge clock input.

Clock (Pin 6) — The counter decrements by one for each rising edge of Clock. See the Function Table for level requirements on the other inputs.

Reset (Pin 10) — A high level on Reset asynchronously forces Q0, Q1, Q2, and Q3 low and, if Cascade Feedback is high, causes the "0" output to go high.

"0" (Pin 12) — The "0" (Zero) output issues a pulse one clock period wide when the counter reaches terminal count (Q0 = Q1 = Q2 = Q3 = low) if Cascade Feedback is high and Preset Enable is low. When presetting the

counter to a value other than all zeroes, the "0" output is valid after the rising edge of Preset Enable (when Cascade Feedback is high). See the Function Table.

Cascade Feedback (Pin 13) — If the Cascade Feedback input is high, a high level is generated at the "0" output when the count is all zeroes. If Cascade Feedback is low, the "0" output depends on the Preset Enable input level. See the Function Table.

P0, P1, P2, P3 (Pins 5, 11, 14, 2) — These are the preset data inputs. P0 is the LSB.

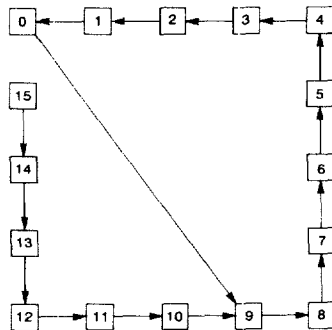
Q0, Q1, Q2, Q3 (Pins 7, 9, 15, 1) — These are the synchronous counter outputs. Q0 is the LSB.

VSS (Pin 8) — The most negative power supply potential. This pin is usually ground.

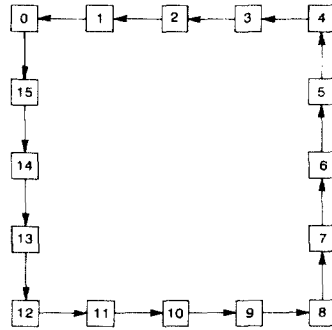
VDD (Pin 16) — The most positive power supply potential. VDD may range from 3 to 18 V with respect to VSS.

STATE DIAGRAMS

MC14522B

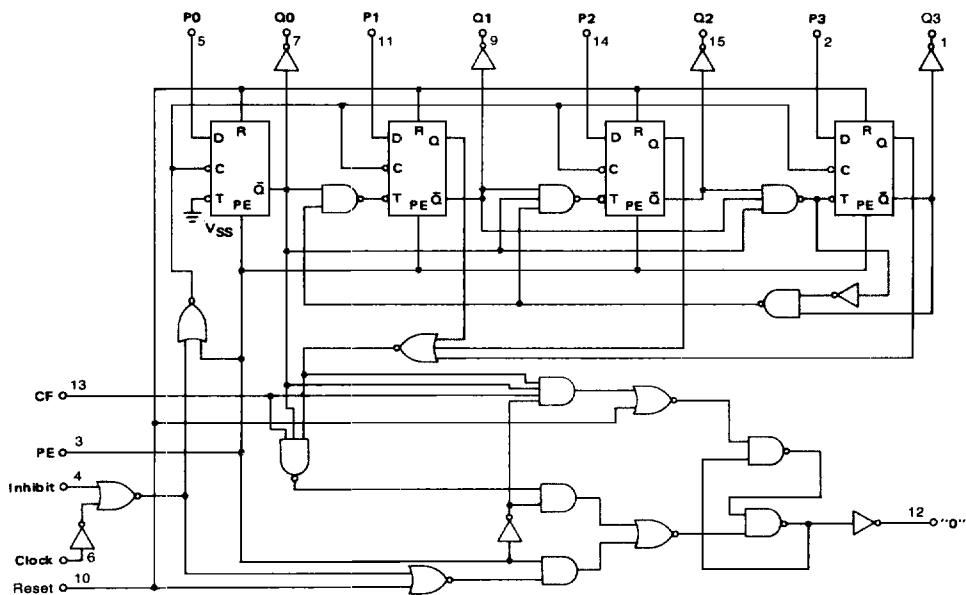


MC14526B

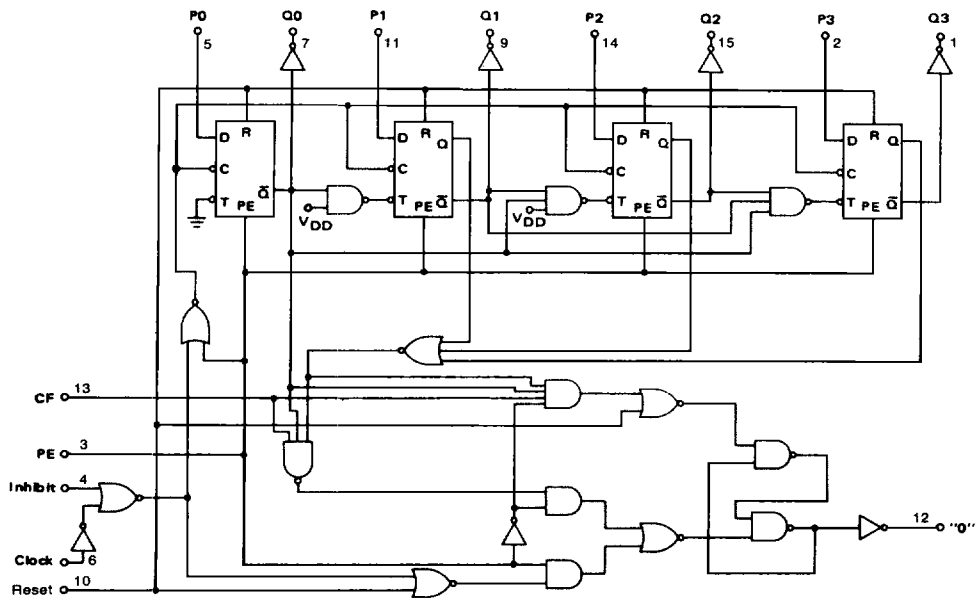


MC14522B•MC14526B

MC14522B LOGIC DIAGRAM (BCD Down Counter)



MC14526B LOGIC DIAGRAM (Binary Down Counter)



MC14522B•MC14526B

APPLICATIONS INFORMATION

Divide-By-N, Single Stage

Figure 11 shows a single stage divide-by-N application. The MC14522B (BCD version) can accept a number greater than 9 and count down in binary fashion. Hence, the BCD and binary single stage divide-by-N counters (as shown in Figure 11) function the same.

To initialize counting a number, N is set on the parallel inputs (P0, P1, P2, and P3) and reset is taken high asynchronously. A zero is forced into the master and slave of each bit and, at the same time, the "0" output goes high. Because Preset Enable is tied to the "0" output, preset is enabled. Reset must be released while the Clock is high so the slaves of each bit may receive N before the Clock goes low. When the Clock goes low and Reset is low, the "0" output goes low (if P0 through P3 are unequal to zero).

The counter downcounts with each rising edge of the Clock. When the counter reaches the zero state, an output pulse occurs on "0" which presets N. The propagation delays from the Clock's rising and falling edges to the "0" output's rising and falling edges are about equal, making the "0" output pulse approximately equal to that of the Clock pulse.

The Inhibit pin may be used to stop pulse counting. When this pin is taken high, decrementing is inhibited.

Cascaded, Presettable Divide-By-N

Figure 12 shows a three stage cascade application. Taking Reset high loads N. Only the first stage's Reset pin (least significant counter) must be taken high to cause the preset for all stages, but all pins could be tied together, as shown.

When the first stage's Reset pin goes high, the "0" output is latched in a high state. Reset must be released while Clock is high and time allowed for Preset Enable to load N into all stages before Clock goes low.

When Preset Enable is high and Clock is low, time must be allowed for the zero digits to propagate a Cascade Feedback to the first non-zero stage. Worst case is from the most significant bit (M.S.B.) to the L.S.B., when the L.S.B. is equal to one (i.e. $N=1$).

After N is loaded, each stage counts down to zero with each rising edge of Clock. When any stage reaches zero and the leading stages (more significant bits) are zero, the "0" output goes high and feeds back to the preceding stage. When all stages are zero, the Preset Enable automatically loads N while the Clock is high and the cycle is renewed.

FIGURE 11 — +N COUNTER

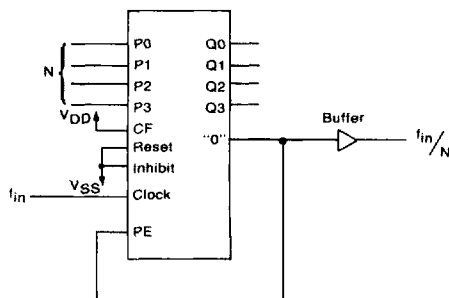


FIGURE 12 — 3 STAGES CASCADED

