

# CD4518BM/CD4518BC, CD4520BM/CD4520BC

## Dual Synchronous Up Counters

### General Description

The CD4518BM/CD4518BC dual BCD counter and the CD4520BM/CD4520BC dual binary counter are implemented with complementary MOS (CMOS) circuits constructed with N- and P-channel enhancement mode transistors.

Each counter consists of two identical, independent, synchronous, 4-stage counters. The counter stages are toggle flip-flops which increment on either the positive-edge of CLOCK or negative-edge of ENABLE, simplifying cascading of multiple stages. Each counter can be asynchronously cleared by a high level on the RESET

line. All inputs are protected against static discharge by diode clamps to both  $V_{DD}$  and  $V_{SS}$ .

### Features

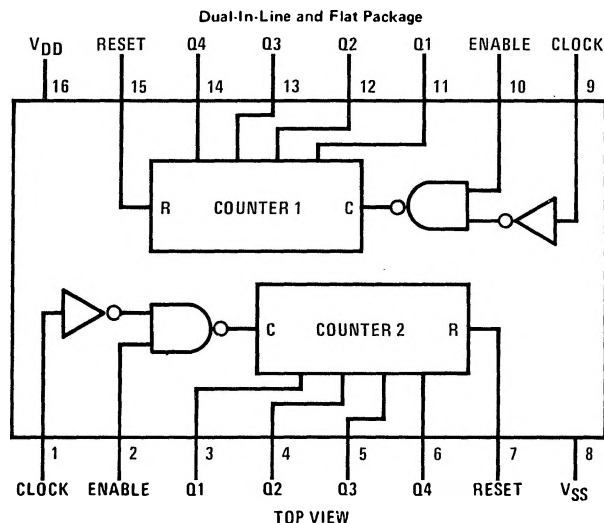
- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45  $V_{DD}$  (typ.)
- Low power TTL compatibility fan out of 2 driving 74L or 1 driving 74LS
- 6MHz counting rate (typ.) at  $V_{DD} = 10V$

### Truth Table

| CLOCK                                                                             | ENABLE                                                                            | RESET | ACTION            |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------|-------------------|
|  | 1                                                                                 | 0     | Increment counter |
| 0                                                                                 |  | 0     | Increment counter |
|  | X                                                                                 | 0     | No change         |
| X                                                                                 |  | 0     | No change         |
|  | 0                                                                                 | 0     | No change         |
| 1                                                                                 |  | 0     | No change         |
| X                                                                                 | X                                                                                 | 1     | Q1 thru Q4 = 0    |

X = Don't Care

### Connection Diagram



**Absolute Maximum Ratings**

(Notes 1 and 2)

|                                                |                          |
|------------------------------------------------|--------------------------|
| $V_{DD}$ Supply Voltage                        | -0.5V to +18V            |
| $V_{IN}$ Input Voltage                         | -0.5V to $V_{DD}$ + 0.5V |
| $T_S$ Storage Temperature Range                | -65°C to +150°C          |
| $P_D$ Package Dissipation                      | 500 mW                   |
| $T_L$ Lead Temperature (Soldering, 10 seconds) | 300°C                    |

**Recommended Operating Conditions**

(Note 2)

|                                   |                 |
|-----------------------------------|-----------------|
| $V_{DD}$ Supply Voltage           | 3V to 15V       |
| $V_{IN}$ Input Voltage            | 0V to $V_{DD}$  |
| $T_A$ Operating Temperature Range | -55°C to +125°C |
| CD4518BM, CD4520BM                | -55°C to +125°C |
| CD4518BC, CD4520BC                | -40°C to +85°C  |

**DC Electrical Characteristics** CD4518BM/CD4520BM (Note 2)

| PARAMETER                          | CONDITIONS                                         | -55°C |      | 25°C  |            |      | 125°C |      | UNITS   |
|------------------------------------|----------------------------------------------------|-------|------|-------|------------|------|-------|------|---------|
|                                    |                                                    | MIN   | MAX  | MIN   | TYP        | MAX  | MIN   | MAX  |         |
| $I_{DD}$ Quiescent Device Current  | $V_{DD} = 5V$                                      |       | 5    |       | 0.01       | 5    |       | 150  | $\mu A$ |
|                                    | $V_{DD} = 10V$                                     |       | 10   |       | 0.01       | 10   |       | 300  | $\mu A$ |
|                                    | $V_{DD} = 15V$                                     |       | 20   |       | 0.01       | 20   |       | 600  | $\mu A$ |
| $V_{OL}$ Low Level Output Voltage  | $ I_{OL}  < 1 \mu A, V_{IH} = V_{DD}, V_{IL} = 0V$ |       |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V$                                      |       | 0.05 |       | 0          | 0.05 |       | 0.05 | V       |
|                                    | $V_{DD} = 10V$                                     |       | 0.05 |       | 0          | 0.05 |       | 0.05 | V       |
|                                    | $V_{DD} = 15V$                                     |       | 0.05 |       | 0          | 0.05 |       | 0.05 | V       |
| $V_{OH}$ High Level Output Voltage | $ I_{OL}  < 1 \mu A, V_{IH} = V_{DD}, V_{IL} = 0V$ |       |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V$                                      | 4.95  |      | 4.95  | 5          |      | 4.95  |      | V       |
|                                    | $V_{DD} = 10V$                                     | 9.95  |      | 9.95  | 10         |      | 9.95  |      | V       |
|                                    | $V_{DD} = 15V$                                     | 14.95 |      | 14.95 | 15         |      | 14.95 |      | V       |
| $V_{IL}$ Low Level Input Voltage   | $ I_{OI}  < 1 \mu A$                               |       |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 0.5V$ or 4.5V                  |       | 1.5  |       | 2.25       | 1.5  |       | 1.5  | V       |
|                                    | $V_{DD} = 10V, V_O = 1V$ or 9V                     |       | 3.0  |       | 4.5        | 3.0  |       | 3.0  | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V                |       | 4.0  |       | 6.75       | 4.0  |       | 4.0  | V       |
| $V_{IH}$ High Level Input Voltage  | $ I_{OI}  < 1 \mu A$                               |       |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 0.5V$ or 4.5V                  | 3.5   |      | 3.5   | 2.75       |      | 3.5   |      | V       |
|                                    | $V_{DD} = 10V, V_O = 1V$ or 9V                     | 7.0   |      | 7.0   | 5.5        |      | 7.0   |      | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V                | 11.0  |      | 11.0  | 8.25       |      | 11.0  |      | V       |
| $I_{OL}$ Low Level Output Current  | $V_{IH} = V_{DD}, V_{IL} = 0V$                     |       |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 0.4V$                          | 0.64  |      | 0.51  | 0.88       |      | 0.36  |      | mA      |
|                                    | $V_{DD} = 10V, V_O = 0.5V$                         | 1.6   |      | 1.3   | 2.25       |      | 0.9   |      | mA      |
|                                    | $V_{DD} = 15V, V_O = 1.5V$                         | 4.2   |      | 3.4   | 8.8        |      | 2.4   |      | mA      |
| $I_{OH}$ High Level Output Current | $V_{IH} = V_{DD}, V_{IL} = 0V$                     |       |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 4.6V$                          | -0.64 |      | -0.51 | -0.88      |      | -0.36 |      | mA      |
|                                    | $V_{DD} = 10V, V_O = 9.5V$                         | -1.6  |      | -1.3  | -2.25      |      | -0.9  |      | mA      |
|                                    | $V_{DD} = 15V, V_O = 13.5V$                        | -4.2  |      | -3.4  | -8.8       |      | -2.4  |      | mA      |
| $I_{IN}$ Input Current             | $V_{DD} = 15V, V_{IN} = 0V$                        |       | -0.1 |       | $-10^{-5}$ | -0.1 |       | -1.0 | $\mu A$ |
|                                    | $V_{DD} = 15V, V_{IN} = 15V$                       |       | 0.1  |       | $10^{-5}$  | 0.1  |       | 1.0  | $\mu A$ |

**DC Electrical Characteristics** CD4518BC/CD4520BC (Note 2)

| PARAMETER                          | CONDITIONS                                         | -40°C |      | 25°C  |      |      | 85°C  |      | UNITS   |
|------------------------------------|----------------------------------------------------|-------|------|-------|------|------|-------|------|---------|
|                                    |                                                    | MIN   | MAX  | MIN   | TYP  | MAX  | MIN   | MAX  |         |
| $I_{DD}$ Quiescent Device Current  | $V_{DD} = 5V$                                      |       | 20   |       | 0.01 | 20   |       | 150  | $\mu A$ |
|                                    | $V_{DD} = 10V$                                     |       | 40   |       | 0.01 | 40   |       | 300  | $\mu A$ |
|                                    | $V_{DD} = 15V$                                     |       | 80   |       | 0.01 | 80   |       | 600  | $\mu A$ |
| $V_{OL}$ Low Level Output Voltage  | $ I_{OL}  < 1 \mu A, V_{IH} = V_{DD}, V_{IL} = 0V$ |       |      |       |      |      |       |      |         |
|                                    | $V_{DD} = 5V$                                      |       | 0.05 |       | 0    | 0.05 |       | 0.05 | V       |
|                                    | $V_{DD} = 10V$                                     |       | 0.05 |       | 0    | 0.05 |       | 0.05 | V       |
|                                    | $V_{DD} = 15V$                                     |       | 0.05 |       | 0    | 0.05 |       | 0.05 | V       |
| $V_{OH}$ High Level Output Voltage | $ I_{OL}  < 1 \mu A, V_{IH} = V_{DD}, V_{IL} = 0V$ |       |      |       |      |      |       |      |         |
|                                    | $V_{DD} = 5V$                                      | 4.95  |      | 4.95  | 5    |      | 4.95  |      | V       |
|                                    | $V_{DD} = 10V$                                     | 9.95  |      | 9.95  | 10   |      | 9.95  |      | V       |
|                                    | $V_{DD} = 15V$                                     | 14.95 |      | 14.95 | 15   |      | 14.95 |      | V       |

**DC Electrical Characteristics** (Cont'd.) CD4518BC/CD4520BC (Note 2)

| PARAMETER                          | CONDITIONS                                   | -40 °C |      | 25 °C |            |      | 85 °C |      | UNITS   |
|------------------------------------|----------------------------------------------|--------|------|-------|------------|------|-------|------|---------|
|                                    |                                              | MIN    | MAX  | MIN   | TYP        | MAX  | MIN   | MAX  |         |
| $V_{IL}$ Low Level Input Voltage   | $ I_{O}  < 1 \mu A$                          |        |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 0.5V \text{ or } 4.5V$   |        | 1.5  |       | 2.25       | 1.5  |       | 1.5  | V       |
|                                    | $V_{DD} = 10V, V_O = 1V \text{ or } 9V$      |        | 3.0  |       | 4.5        | 3.0  |       | 3.0  | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V \text{ or } 13.5V$ |        | 4.0  |       | 6.75       | 4.0  |       | 4.0  | V       |
| $V_{IH}$ High Level Input Voltage  | $ I_{O}  < 1 \mu A$                          |        |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 0.5V \text{ or } 4.5V$   | 3.5    |      | 3.5   | 2.75       |      | 3.5   |      | V       |
|                                    | $V_{DD} = 10V, V_O = 1V \text{ or } 9V$      | 7.0    |      | 7.0   | 5.5        |      | 7.0   |      | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V \text{ or } 13.5V$ | 11.0   |      | 11.0  | 8.25       |      | 11.0  |      | V       |
| $I_{OL}$ Low Level Output Current  | $V_{IH} = V_{DD}, V_{IL} = 0V$               |        |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 0.4V$                    | 0.52   |      | 0.44  | 0.88       |      | 0.36  |      | mA      |
|                                    | $V_{DD} = 10V, V_O = 0.5V$                   | 1.3    |      | 1.1   | 2.25       |      | 0.9   |      | mA      |
|                                    | $V_{DD} = 15V, V_O = 1.5V$                   | 3.6    |      | 3.0   | 8.8        |      | 2.4   |      | mA      |
| $I_{OH}$ High Level Output Current | $V_{IH} = V_{DD}, V_{IL} = 0V$               |        |      |       |            |      |       |      |         |
|                                    | $V_{DD} = 5V, V_O = 4.6V$                    | -0.52  |      | -0.44 | -0.88      |      | -0.36 |      | mA      |
|                                    | $V_{DD} = 10V, V_O = 9.5V$                   | -1.3   |      | -1.1  | -2.25      |      | -0.9  |      | mA      |
|                                    | $V_{DD} = 15V, V_O = 13.5V$                  | -3.6   |      | -3.0  | -8.8       |      | -2.4  |      | mA      |
| $I_{IN}$ Input Current             | $V_{DD} = 15V, V_{IN} = 0V$                  |        | -0.3 |       | $-10^{-5}$ | -0.3 |       | -1.0 | $\mu A$ |
|                                    | $V_{DD} = 15V, V_{IN} = 15V$                 |        | 0.3  |       | $10^{-5}$  | 0.3  |       | 1.0  | $\mu A$ |

**AC Electrical Characteristics**  $T_A = 25^\circ C$ ,  $C_L = 50 \text{ pF}$ ,  $R_L = 200 \text{ k}\Omega$ ,  $t_r = t_f = 20 \text{ ns}$ , unless otherwise specified.

| PARAMETER                                                        | CONDITIONS               | MIN | TYP | MAX | UNITS   |
|------------------------------------------------------------------|--------------------------|-----|-----|-----|---------|
| $t_{PHL}, t_{PLH}$ Propagation Delay Time, Clock $\rightarrow$ Q | $V_{DD} = 5V$            |     | 325 | 650 | ns      |
|                                                                  | $V_{DD} = 10V$           |     | 110 | 225 | ns      |
|                                                                  | $V_{DD} = 15V$           |     | 85  | 170 | ns      |
| $t_{PHL}$ Propagation Delay Time Reset $\rightarrow$ Q           | $V_{DD} = 5V$            |     | 220 | 560 | ns      |
|                                                                  | $V_{DD} = 10V$           |     | 90  | 230 | ns      |
|                                                                  | $V_{DD} = 15V$           |     | 65  | 160 | ns      |
| $t_{THL}, t_{TLH}$ Transition Time                               | $V_{DD} = 5V$            |     | 100 | 200 | ns      |
|                                                                  | $V_{DD} = 10V$           |     | 50  | 100 | ns      |
|                                                                  | $V_{DD} = 15V$           |     | 40  | 80  | ns      |
| $f_{CL}$ Maximum Clock Input Frequency                           | $V_{DD} = 5V$            | 1.5 | 3   |     | MHz     |
|                                                                  | $V_{DD} = 10V$           | 3.0 | 6   |     | MHz     |
|                                                                  | $V_{DD} = 15V$           | 4.0 | 8   |     | MHz     |
| $t_{WL}, t_{WH}$ Minimum Clock Pulse Width                       | $V_{DD} = 5V$            |     | 100 | 200 | ns      |
|                                                                  | $V_{DD} = 10V$           |     | 50  | 100 | ns      |
|                                                                  | $V_{DD} = 15V$           |     | 35  | 70  | ns      |
| $t_{RCL}, t_{FC}$ Maximum Clock or Enable Rise and Fall Time     | $V_{DD} = 5V$            | 15  |     |     | $\mu s$ |
|                                                                  | $V_{DD} = 10V$           | 10  |     |     | $\mu s$ |
|                                                                  | $V_{DD} = 15V$           | 5   |     |     | $\mu s$ |
| $t_{WH}, t_{WL}$ Minimum Enable Pulse Width                      | $V_{DD} = 5V$            |     | 125 | 250 | ns      |
|                                                                  | $V_{DD} = 10V$           |     | 55  | 110 | ns      |
|                                                                  | $V_{DD} = 15V$           |     | 40  | 80  | ns      |
| $t_{WH}$ Minimum Reset Pulse Width                               | $V_{DD} = 5V$            |     | 180 | 375 | ns      |
|                                                                  | $V_{DD} = 10V$           |     | 80  | 160 | ns      |
|                                                                  | $V_{DD} = 15V$           |     | 65  | 130 | ns      |
| $C_{IN}$ Input Capacitance                                       | Any Input                |     | 5   | 7.5 | pF      |
| $C_{PD}$ Power Dissipation Capacity                              | Either Counter, (Note 3) |     | 50  |     | pF      |

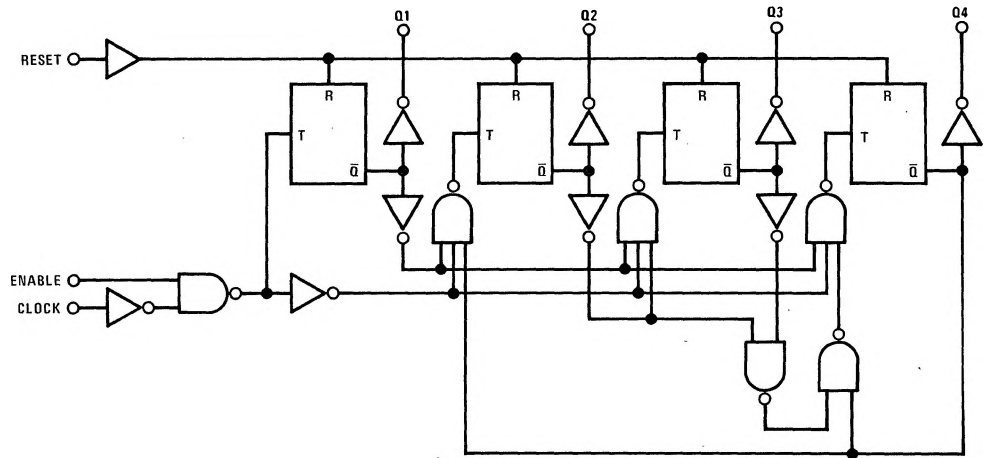
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and "Electrical Characteristics" provide conditions for actual device operation.

Note 2:  $V_{SS} = 0V$  unless otherwise specified.

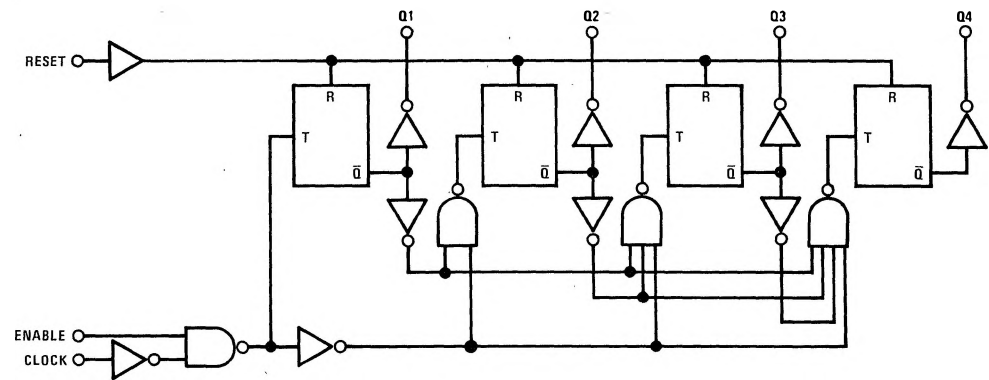
Note 3:  $C_{PD}$  determines the no load ac power consumption of a CMOS device. For a complete explanation, see "54C/74C Family Characteristics," application note AN-90.

# Logic Diagrams

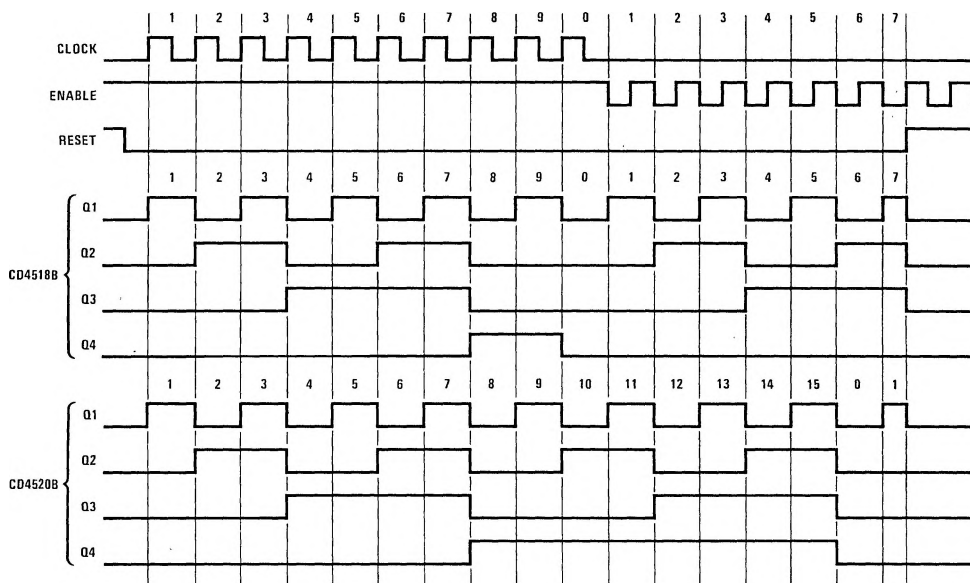
Decade Counter (CD4518B) 1/2 Device Shown



Binary Counter (CD4520B) 1/2 Device Shown



## Timing Diagrams



## Switching Time Waveforms

