



# 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

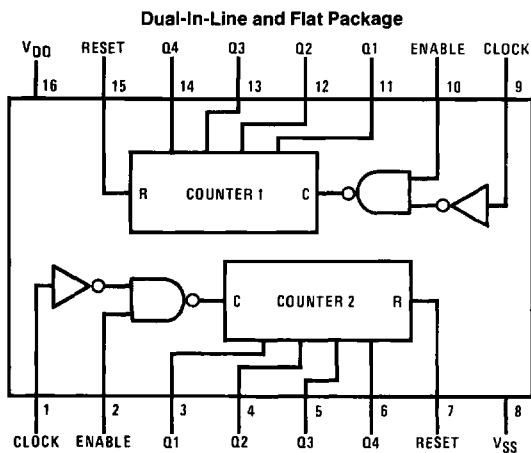
- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45  $V_{DD}$  (typ.)
- Low power TTL compatibility fan out of 2 driving 74L or 1 driving 74LS
- 6 MHz counting rate (typ.) at  $V_{DD} = 10V$

## 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



Top View

TL/F/5895-1

**Order Number CD4518B\* or CD4520B\***

\*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 <sub>DD</sub> )	-0.5V to +18V
Input Voltage (V <sub>IN</sub> )	-0.5V to V <sub>DD</sub> + 0.5V
Storage Temperature Range (T <sub>S</sub> )	-65°C to +150°C
Power Dissipation (P <sub>D</sub> )	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T <sub>L</sub> )	
(Soldering, 10 seconds)	260°C

### Recommended Operating Conditions (Note 2)

Supply Voltage (V <sub>DD</sub> )	3V to 15V
Input Voltage (V <sub>IN</sub> )	0V to V <sub>DD</sub>
Operating Temperature Range (T <sub>A</sub> )	
CD4518BM, CD4520BM	-55°C to +125°C
CD4518BC, CD4520BC	-40°C to +85°C

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

Symbol	Parameter	Conditions	-55°C		+25°C			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I <sub>DD</sub>	Quiescent Device Current	V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V		5 10 20		0.01 0.01 0.01	5 10 20		150 300 600	μA μA μA
V <sub>OL</sub>	Low Level Output Voltage	I <sub>O</sub>   < 1μA, V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V		0.05 0.05 0.05		0 0 0	0.05 0.05 0.05		0.05 0.05 0.05	V V V
V <sub>OH</sub>	High Level Output Voltage	I <sub>O</sub>   < 1μA, V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V V V
V <sub>IL</sub>	Low Level Input Voltage	I <sub>O</sub>   < 1μA V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V		1.5 3.0 4.0		2.25 4.5 6.75	1.5 3.0 4.0		1.5 3.0 4.0	V V V
V <sub>IH</sub>	High Level Input Voltage	I <sub>O</sub>   < 1μA V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V	3.5 7.0 11.0		3.5 7.0 11.0	2.75 5.5 8.25		3.5 7.0 11.0		V V V
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V	0.64 1.6 4.2		0.51 1.3 3.4	0.88 2.25 8.8		0.36 0.9 2.4		mA mA mA
I <sub>OH</sub>	High Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V	-0.64 -1.6 -4.2		-0.51 -1.3 -3.4	-0.88 -2.25 -8.8		-0.36 -0.9 -2.4		mA mA mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V		-0.1 0.1		-10 <sup>-5</sup> 10 <sup>-5</sup>	-0.1 0.1		-1.0 1.0	μA μA

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

Symbol	Parameter	Conditions	-40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I <sub>DD</sub>	Quiescent Device Current	V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V		20 40 80		0.01 0.01 0.01	20 40 80		150 300 600	μA μA μA
V <sub>OL</sub>	Low Level Output Voltage	I <sub>O</sub>   < 1μA, V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V		0.05 0.05 0.05		0 0 0	0.05 0.05 0.05		0.05 0.05 0.05	V V V
V <sub>OH</sub>	High Level Output Voltage	I <sub>O</sub>   < 1μA, V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V V V

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

Symbol	Parameter	Conditions	-40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
V <sub>IL</sub>	Low Level Input Voltage	I <sub>O</sub>   < 1 μA V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V								
				1.5		2.25	1.5		1.5	V
				3.0		4.5	3.0		3.0	V
				4.0		6.75	4.0		4.0	V
V <sub>IH</sub>	High Level Input Voltage	I <sub>O</sub>   < 1 μA V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V								
			3.5		3.5	2.75		3.5		V
			7.0		7.0	5.5		7.0		V
			11.0		11.0	8.25		11.0		V
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V								
			0.52		0.44	0.88		0.36		mA
			1.3		1.1	2.25		0.9		mA
			3.6		3.0	8.8		2.4		mA
I <sub>OH</sub>	High Level Output Current (Note 3)	V <sub>IH</sub> = V <sub>DD</sub> , V <sub>IL</sub> = 0V V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V								
			-0.52		-0.44	-0.88		-0.36		mA
			-1.3		-1.1	-2.25		-0.9		mA
			-3.6		-3.0	-8.8		-2.4		mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V		-0.3		-10 <sup>-5</sup>	-0.3		-1.0	μA
				0.3		10 <sup>-5</sup>	0.3		1.0	μA

**AC Electrical Characteristics\***T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200 kΩ, t<sub>r</sub> = t<sub>f</sub> = 20 ns, unless otherwise specified

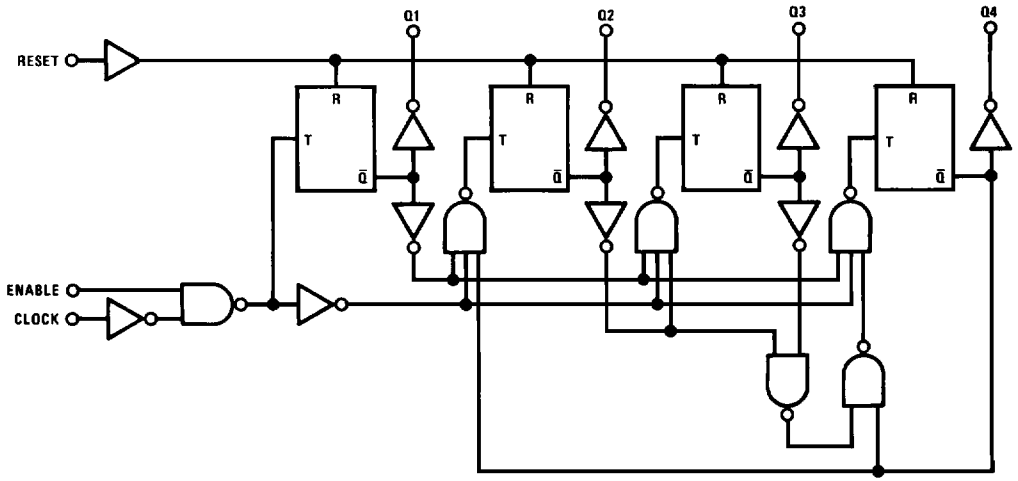
Symbol	Parameter	Conditions	Min	Typ	Max	Units
t <sub>PHL</sub> , t <sub>PLH</sub>	Propagation Delay Time Clock → Q	V <sub>DD</sub> = 5V		325	650	ns
		V <sub>DD</sub> = 10V		110	225	ns
		V <sub>DD</sub> = 15V		85	170	ns
t <sub>PHL</sub>	Propagation Delay Time Reset → Q	V <sub>DD</sub> = 5V		220	560	ns
		V <sub>DD</sub> = 10V		90	230	ns
		V <sub>DD</sub> = 15V		65	160	ns
t <sub>THL</sub> , t <sub>TLH</sub>	Transition Time	V <sub>DD</sub> = 5V		100	200	ns
		V <sub>DD</sub> = 10V		50	100	ns
		V <sub>DD</sub> = 15V		40	80	ns
f <sub>CL</sub>	Maximum Clock Input Frequency	V <sub>DD</sub> = 5V	1.5	3		MHz
		V <sub>DD</sub> = 10V	3.0	6		MHz
		V <sub>DD</sub> = 15V	4.0	8		MHz
t <sub>WL</sub> , t <sub>WH</sub>	Minimum Clock Pulse Width	V <sub>DD</sub> = 5V		10	200	ns
		V <sub>DD</sub> = 10V		50	100	ns
		V <sub>DD</sub> = 15V		35	70	ns
t <sub>RCL</sub> , t <sub>FC</sub>	Maximum Clock or Enable Rise and Fall Time	V <sub>DD</sub> = 5V	15			μs
		V <sub>DD</sub> = 10V	10			μs
		V <sub>DD</sub> = 15V	5			μs
t <sub>WH</sub> , t <sub>WL</sub>	Minimum Enable Pulse Width	V <sub>DD</sub> = 5V		125	250	ns
		V <sub>DD</sub> = 10V		55	110	ns
		V <sub>DD</sub> = 15V		40	80	ns
t <sub>WH</sub>	Minimum Reset Pulse Width	V <sub>DD</sub> = 5V		180	375	ns
		V <sub>DD</sub> = 10V		80	160	ns
		V <sub>DD</sub> = 15V		65	130	ns
C <sub>IN</sub>	Input Capacitance	Any Input		5	7.5	pF
C <sub>PD</sub>	Power Dissipation Capacity	Either Counter (Note 4)		50		pF

\*AC Parameters are guaranteed by DC correlated testing.

**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<sub>SS</sub> = 0V unless otherwise specified.**Note 3:** I<sub>OH</sub> and I<sub>OL</sub> are tested one output at a time.**Note 4:** C<sub>PD</sub> determines the no load AC power consumption of a CMOS device. For a complete explanation, see "54C/74C Family Characteristics", application note AN-90.

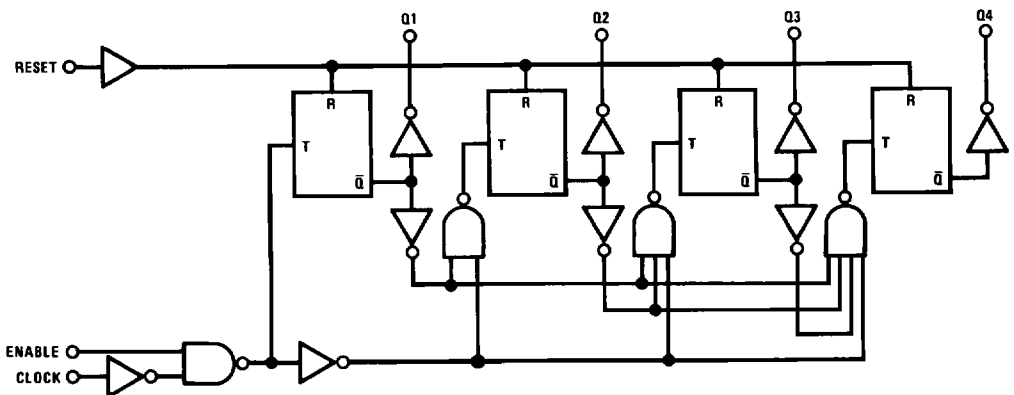
Logic Diagrams

Decade Counter (CD4518B) 1/2 Device Shown



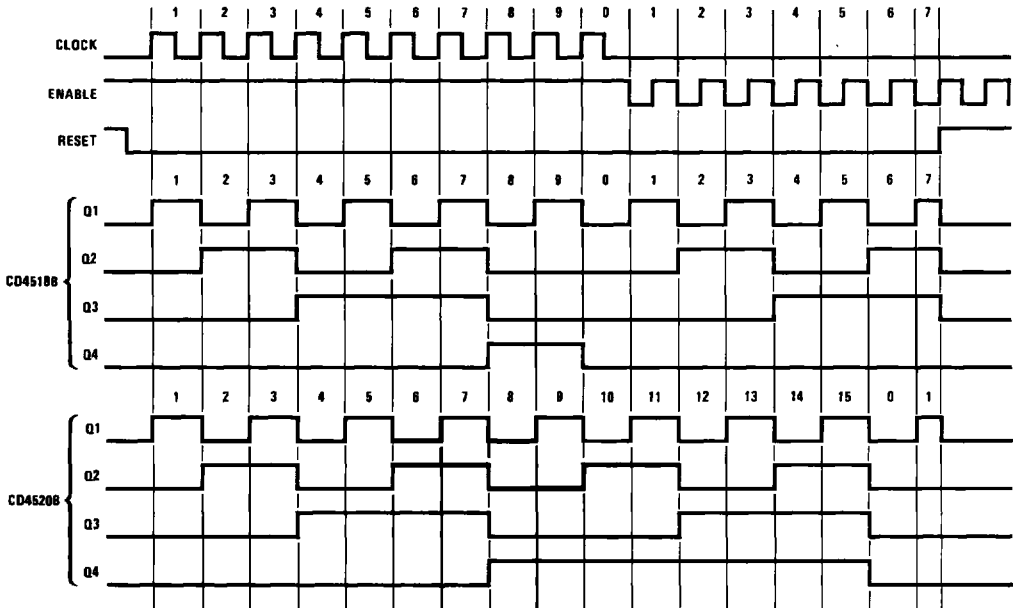
TL/F/5995-2

Binary Counter (CD4520B) 1/2 Device Shown



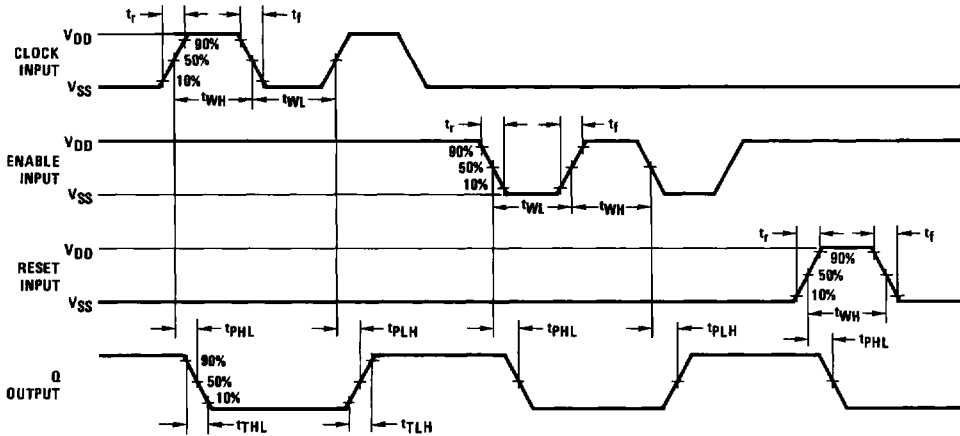
TL/F/5995-3

### Timing Diagrams



TL/F/5995-4

### Switching Time Waveforms



TL/F/5995-5