National *Semiconductor*

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CD4020BM/CD4020BC
14-Stage Ripple Carry Binary Counters
CD4040BM/CD4040BC
12-Stage Ripple Carry Binary Counters
CD4060BM/CD4060BC
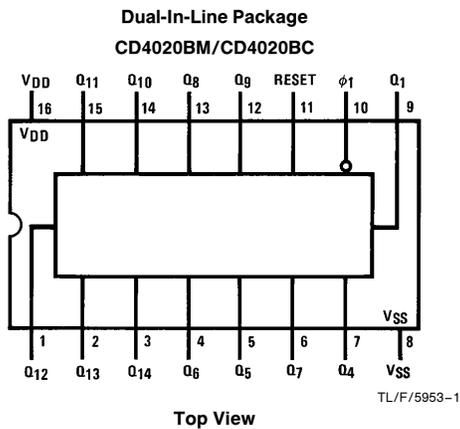## 14-Stage Ripple Carry Binary Counters

General Description

The CD4020BM/CD4020BC, CD4060BM/CD4060BC are 14-stage ripple carry binary counters, and the CD4040BM/CD4040BC is a 12-stage ripple carry binary counter. The counters are advanced one count on the negative transition of each clock pulse. The counters are reset to the zero state by a logical "1" at the reset input independent of clock.
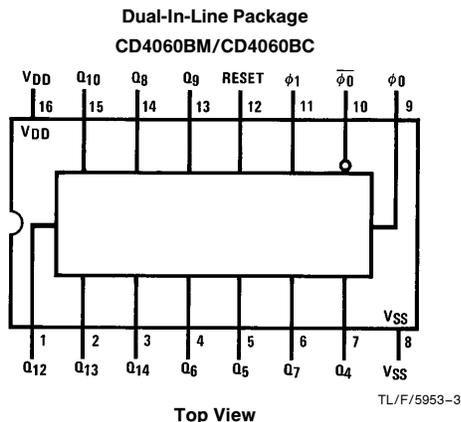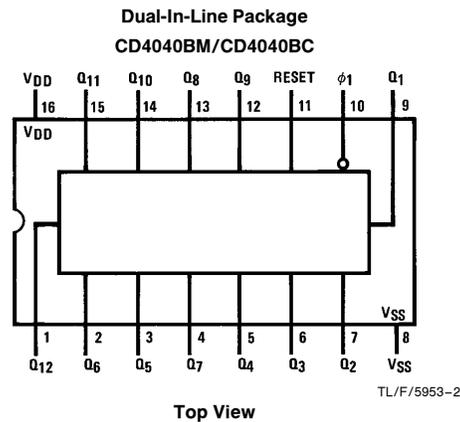
Features

■ Wide supply voltage range   1.0V to 15V
■ High noise immunity   0.45 V_{DD} (typ.)
■ Low power TTL   Fan out of 2 driving 74L
  compatibility   or 1 driving 74LS
■ Medium speed operation   8 MHz typ. at $V_{DD} = 10V$
■ Schmitt trigger clock input

Connection Diagrams

Dual-In-Line Package
CD4020BM/CD4020BC

Top View

TL/F/5953–1

Order Number CD4020B, CD4040B or CD4060B

Dual-In-Line Package
CD4040BM/CD4040BC

Top View

TL/F/5953–2

Dual-In-Line Package
CD4060BM/CD4060BC

Top View

TL/F/5953–3

Absolute Maximum Ratings (Notes 1 and 2)

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

Supply Voltage (V_{DD})	$-0.5V$ to $+18V$
Input Voltage (V_{IN})	$-0.5V$ to $V_{DD} +0.5V$
Storage Temperature Range (T_S)	$-65°C$ to $+150°C$
Package Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T_L)	
(Soldering, 10 seconds)	260°C

Recommended Operating Conditions

Supply Voltage (V_{DD})	$+3V$ to $+15V$
Input Voltage (V_{IN})	0V to V_{DD}
Operating Temperature Range (T_A)	
CD40XXBM	$-55°C$ to $+125°C$
CD40XXBC	$-40°C$ to $+85°C$

DC Electrical Characteristics CD40XXBM (Note 2)

Symbol	Parameter	Conditions	$-55°C$		$+25°C$			$+125°C$		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Device Current	$V_{DD} = 5V$, $V_{IN} = V_{DD}$ or V_{SS}		5			5		150	μA
		$V_{DD} = 10V$, $V_{IN} = V_{DD}$ or V_{SS}		10			10		300	μA
		$V_{DD} = 15V$, $V_{IN} = V_{DD}$ or V_{SS}		20			20		600	μA
V_{OL}	Low Level Output Voltage	$V_{DD} = 5V$		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	$V_{DD} = 5V$	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	$V_{DD} = 5V$, $V_O = 0.5V$ or 4.5V		1.5		2	1.5		1.5	V
		$V_{DD} = 10V$, $V_O = 1.0V$ or 9.0V		3.0		4	3.0		3.0	V
		$V_{DD} = 15V$, $V_O = 1.5V$ or 13.5V		4.0		6	4.0		4.0	V
V_{IH}	High Level Input Voltage	$V_{DD} = 5V$, $V_O = 0.5V$ or 4.5V	3.5		3.5	3		3.5		V
		$V_{DD} = 10V$, $V_O = 1.0V$ or 9.0V	7.0		7.0	6		7.0		V
		$V_{DD} = 15V$, $V_O = 1.5V$ or 13.5V	11.0		11.0	9		11.0		V
I_{OL}	Low Level Output Current (See Note 3)	$V_{DD} = 5V$, $V_O = 0.4V$	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 (See Note 3)	$V_{DD} = 5V$, $V_O = 4.6V$	-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	$V_{DD} = 15V$, $V_{IN} = 0V$		-0.10		-10^{-5}	-0.10		-1.0	μA
		$V_{DD} = 15V$, $V_{IN} = 15V$		0.10		10^{-5}	0.10		1.0	μA

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: Data does not apply to oscillator points ϕ_0 and $\overline{\phi_0}$ of CD4060BM/CD4060BC. I_{OH} and I_{OL} are tested one output at a time.

DC Electrical Characteristics 40XXBC (Note 2)

Symbol	Parameter	Conditions	$-40°C$		$+25°C$			$+85°C$		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Device Current	$V_{DD} = 5V$, $V_{IN} = V_{DD}$ or V_{SS}		20			20		150	μA
		$V_{DD} = 10V$, $V_{IN} = V_{DD}$ or V_{SS}		40			40		300	μA
		$V_{DD} = 15V$, $V_{IN} = V_{DD}$ or V_{SS}		80			80		600	μA
V_{OL}	Low Level Output Voltage	$V_{DD} = 5V$		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

DC Electrical Characteristics 40XXBC (Note 2) (Continued)

Symbol	Parameter	Conditions	−40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
V_{OH}	High Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	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_{IL}	Low Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$		1.5 3.0 4.0		2 4 6	1.5 3.0 4.0		1.5 3.0 4.0	V V V
V_{IH}	High Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$	3.5 7.0 11.0		3.5 7.0 11.0	3 6 9		3.5 7.0 11.0		V V V
I_{OL}	Low Level Output Current (See Note 3)	$V_{DD} = 5V, V_O = 0.4V$ $V_{DD} = 10V, V_O = 0.5V$ $V_{DD} = 15V, V_O = 1.5V$	0.52 1.3 3.6		0.44 1.1 3.0	0.88 2.25 8.8		0.36 0.9 2.4		mA mA mA
I_{OH}	High Level Output Current (See Note 3)	$V_{DD} = 5V, V_O = 4.6V$ $V_{DD} = 10V, V_O = 9.5V$ $V_{DD} = 15V, V_O = 13.5V$	−0.52 −1.3 −3.6		−0.44 −1.1 −3.0	−0.88 −2.25 −8.8		−0.36 −0.9 −2.4		mA mA mA
I_{IN}	Input Current	$V_{DD} = 15V, V_{IN} = 0V$ $V_{DD} = 15V, V_{IN} = 15V$		−0.30 0.30		-10^{-5} 10^{-5}	−0.30 0.30		−1.0 1.0	μA μA

AC Electrical Characteristics* CD4020BM/CD4020BC, CD4040BM/CD4040BC
$T_A = 25°C$, $C_L = 50$ pF, $R_L = 200k$, $t_r = t_f = 20$ ns, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PHL1}, t_{PLH1}	Propagation Delay Time to Q_1	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		250 100 75	550 210 150	ns ns ns
t_{PHL}, t_{PLH}	Interstage Propagation Delay Time from Q_n to Q_{n+1}	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		150 60 45	330 125 90	ns ns ns
t_{THL}, t_{TLH}	Transition Time	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		100 50 40	200 100 80	ns ns ns
t_{WL}, t_{WH}	Minimum Clock Pulse Width	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		125 50 40	335 125 100	ns ns ns
t_{rCL}, t_{fCL}	Maximum Clock Rise and Fall Time	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$			No Limit No Limit No Limit	ns ns ns
f_{CL}	Maximum Clock Frequency	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	1.5 4 5	4 10 12		MHz MHz MHz
$t_{PHL(R)}$	Reset Propagation Delay	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		200 100 80	450 210 170	ns ns ns
$t_{WH(R)}$	Minimum Reset Pulse Width	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		200 100 80	450 210 170	ns ns ns
C_{in}	Average Input Capacitance	Any Input		5	7.5	pF
C_{pd}	Power Dissipation Capacitance			50		pF

*AC Parameters are guaranteed by DC correlated testing.

AC Electrical Characteristics* CD4060BM/CD4060BC

$T_A = 25°C$, $C_L = 50$ pF, $R_L = 200k$, $t_r = t_f = 20$ ns, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PHL4}, t_{PLH4}	Propagation Delay Time to Q_4	$V_{DD} = 5V$		550	1300	ns
		$V_{DD} = 10V$		250	525	ns
		$V_{DD} = 15V$		200	400	ns
t_{PHL}, t_{PLH}	Interstage Propagation Delay Time from Q_n to Q_{n+1}	$V_{DD} = 5V$		150	330	ns
		$V_{DD} = 10V$		60	125	ns
		$V_{DD} = 15V$		45	90	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
t_{WL}, t_{WH}	Minimum Clock Pulse Width	$V_{DD} = 5V$		170	500	ns
		$V_{DD} = 10V$		65	170	ns
		$V_{DD} = 15V$		50	125	ns
t_{rCL}, t_{fCL}	Maximum Clock Rise and Fall Time	$V_{DD} = 5V$			No Limit	ns
		$V_{DD} = 10V$			No Limit	ns
		$V_{DD} = 15V$			No Limit	ns
f_{CL}	Maximum Clock Frequency	$V_{DD} = 5V$	1	3		MHz
		$V_{DD} = 10V$	3	8		MHz
		$V_{DD} = 15V$	4	10		MHz
$t_{PHL(R)}$	Reset Propagation Delay	$V_{DD} = 5V$		200	450	ns
		$V_{DD} = 10V$		100	210	ns
		$V_{DD} = 15V$		80	170	ns
$t_{WH(R)}$	Minimum Reset Pulse Width	$V_{DD} = 5V$		200	450	ns
		$V_{DD} = 10V$		100	210	ns
		$V_{DD} = 15V$		80	170	ns
C_{in}	Average Input Capacitance	Any Input		5	7.5	pF
C_{pd}	Power Dissipation Capacitance			50		pF

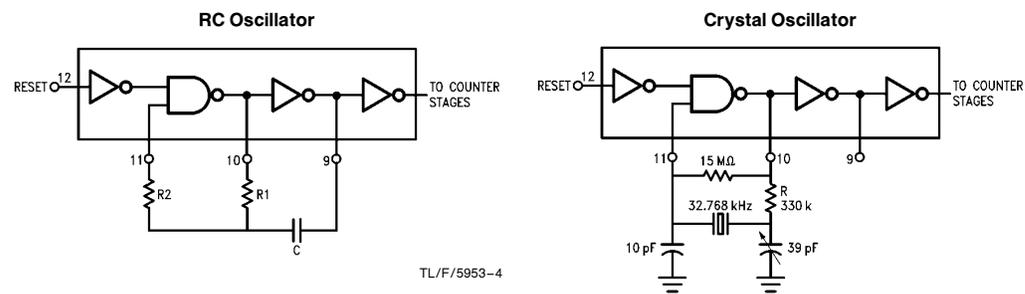*AC Parameters are guaranteed by DC correlated testing.

CD4060B Typical Oscillator Connections

RC Oscillator
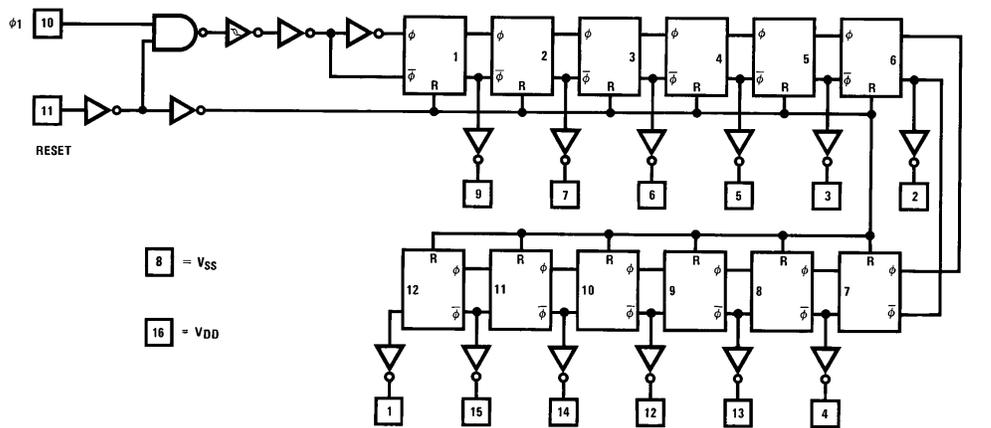

TL/F/5953–4

Crystal Oscillator

TL/F/5953–5

Schematic Diagrams

CD4020BM/CD4020BC Schematic Diagram

TL/F/5953–6
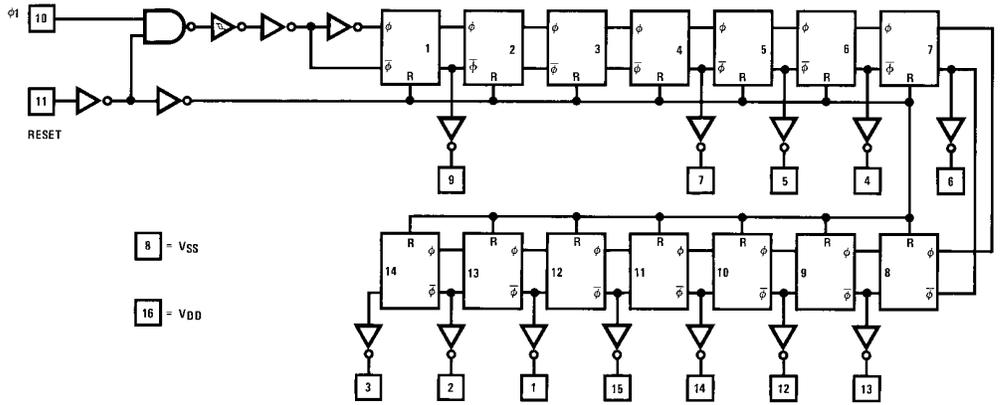
CD4040BM/CD4040BC Schematic Diagram

TL/F/5953–7

CD4060BM/CD4060BC Schematic Diagram

TL/F/5953–8

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Physical Dimensions inches (millimeters)

Ceramic Dual-In-Line Package (J)
Order Number CD4020BMJ, CD4020BCJ,
CD4040BMJ, CD4040BCJ, CD4060BMJ or CD4060BCJ
NS Package Number J16A

Molded Dual-In-Line Package (N)
Order Number CD4020BMN, CD4020BCN,
CD4040BMN, CD4040BCN, CD4060BMN or CD4060BCN
NS Package Number N16E

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