

March 1988

CD40160BM/CD40160BC Decade Counter with Asynchronous Clear CD40161BM/CD40161BC Binary Counter with Asynchronous Clear CD40162BM/CD40162BC Decade Counter with Synchronous Clear CD40163BM/CD40163BC Binary Counter with Synchronous Clear

General Description

These (synchronous presettable up) counters are monolithic complementary MOS (CMOS) integrated circuits constructed with N- and P-channel enhancement mode transistors. They feature an internal carry look-ahead for fast counting schemes and for cascading packages without additional gating.

A low level at the load input disables counting and causes the outputs to agree with the data input after the next positive clock edge. The clear function for the CD40162B and CD40163B is synchronous and a low level at the clear input sets all four outputs low after the next positive clock edge. The clear function for the CD40160B and CD40161B is asynchronous and a low level at the clear input sets all four outputs low, regardless of the state of the clock.

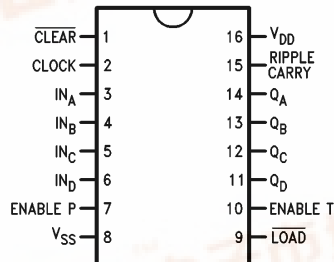
Counting is enabled when both count enable inputs are high. Input T is fed forward to also enable the carry out. The carry output is a positive pulse with a duration approximately equal to the positive portion of Q_A and can be used to enable successive cascaded stages. Logic transitions at the enable P or T inputs can occur when the clock is high or low.

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
- Internal look-ahead for fast counting schemes
- Carry output for N-bit cascading
- Load control line
- Synchronously programmable
- Equivalent to MC14160B, MC14161B, MC14162B, MC14163B
- Equivalent to MM74C160, MM74C161, MM74C162, MM74C163

Connection Diagram

Dual-In-Line Package



Top View

TL/F/5986-1

Order Number CD40160B, CD40161B,
CD40162B or CD40163B

CD40160BM/BC Decade Counter with Asynchronous Clear, CD40162BM/BC Synchronous Clear, CD40161BM/BC Binary Counter with Asynchronous Clear, CD40163BM/BC Synchronous Clear



Absolute Maximum Ratings (Notes 1 & 2)

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

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

Recommended Operating Conditions (Note 2)

DC Supply Voltage (V_{DD})	3V to 15 V_{DC}
Input Voltage (V_{IN})	0V to V_{DD} V_{DC}
Operating Temperature Range (T_A)	
CD40XXBXM	–55°C to +125°C
CD40XXBC	–40°C to +85°C

DC Electrical Characteristics CD40160BM/CD40161BM/CD40162BM/CD40163BM (Note 2)

Symbol	Parameter	Conditions	Limits							Units
			− 55°C		+ 25°C			+ 125°C		
			Min	Max	Min	Typ	Max	Min	Max	
I _{DD}	Quiescent Device Current	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		5 10 20			5 10 20		150 300 600	μA μA μA
V _{OL}	Low Level Output Voltage	I _O < 1 μA V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		0.05 0.05 0.05			0.05 0.05 0.05		0.05 0.05 0.05	V V V
V _{OH}	High Level Output Voltage	I _O < 1 μA 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 = 1V or 9V V _{DD} = 15V, V _O = 1.5V or 13.5V		1.5 3.0 4.0			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 = 1V or 9V V _{DD} = 15V, V _O = 1.5V or 13.5V	3.5 7.0 11.0		3.5 7.0 11.0			3.5 7.0 11.0		V V V
I _{OL}	Low Level Output Current (Note 3)	V _{DD} = 5V, V _O = 0.4V V _{DD} = 10V, V _O = 0.5V V _{DD} = 15V, V _O = 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 _{OH}	High Level Output Current (Note 3)	V _{DD} = 5V, V _O = 4.6V V _{DD} = 10V, V _O = 9.5V V _{DD} = 15V, V _O = 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 _{IN}	Input Current	V _{DD} = 15V, V _{IN} = 0V V _{DD} = 15V, V _{IN} = 15V		−0.10 0.10		−10 ^{−5} 10 ^{−5}	−0.10 0.10		−1.0 1.0	μA μA

DC Electrical Characteristics CD40160BC/CD40161BC/CD40162BC/CD40163BC (Note 2)

Symbol	Parameter	Conditions	Limits							Units
			−40°C		+25°C			+85°C		
			Min	Max	Min	Typ	Max	Min	Max	
I _{DD}	Quiescent Device Current	V _{DD} = 5V		20			20		150	μA
		V _{DD} = 10V		40			40		300	μA
		V _{DD} = 15V		80			80		600	μA
V _{OL}	Low Level Output Voltage	I _O < 1 μA								
		V _{DD} = 5V		0.05			0.05		0.05	V
		V _{DD} = 10V		0.05			0.05		0.05	V
		V _{DD} = 15V		0.05			0.05		0.05	V
V _{OH}	High Level Output Voltage	I _O < 1 μA								
		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			1.5		1.5	V
		V _{DD} = 10V, V _O = 1V or 9V		3.0			3.0		3.0	V
		V _{DD} = 15V, V _O = 1.5V or 13.5V		4.0			4.0		4.0	V

DC Electrical Characteristics CD40160BC/CD40161BC/CD40162BC/CD40163BC (Note 2) (Continued)

Symbol	Parameter	Conditions	Limits						Units
			−40°C		+25°C			+85°C	
			Min	Max	Min	Typ	Max	Min	Max
V _{IH}	High Level Input Voltage	V _{DD} = 5V, V _O = 0.5V or 4.5V V _{DD} = 10V, V _O = 1V or 9V V _{DD} = 15V, V _O = 1.5V or 13.5V	3.5 7.0 11.0		3.5 7.0 11.0			3.5 7.0 11.0	V V V
I _{OL}	Low Level Output Current (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 (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* T_A = 25°C, C_L = 50 pF, R_L = 200k, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t _{PHL} or t _{PLH}	Propagation Delay Time from Clock to Q	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		250 100 80	400 160 130	ns ns ns
t _{PHL} or t _{PLH}	Propagation Delay Time from Clock to Carry Out	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		290 120 100	450 190 160	ns ns ns
t _{PHL} or t _{PLH}	Propagation Delay Time from T Enable to Carry Out	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		180 70 60	290 130 110	ns ns ns
t _{PHL}	Propagation Time from Clear to Q (CD40160B, CD40161B Only)	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		190 80 70	300 150 120	ns ns ns
t _{SU}	Minimum Time Prior to Clock that Data or Load must be Present	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		120 30 25		ns ns ns
t _{SU}	Minimum Time Prior to Clock that Enable P or T must be Present	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		170 70 60	280 120 100	ns ns ns
t _{SU}	Minimum Time Prior to Clock that Clear must be Present (CD40162B, CD40163B Only)	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		120 50 40	190 80 70	ns ns ns
t _{WL} or t _{WH}	Maximum Clock Pulse Width	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		125 45 35	250 90 70	ns ns ns
t _{RCL} or t _{FCL}	Maximum Clock Rise or Fall Time	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V			15 5.0 5.0	μs μs μs
f _{CL}	Maximum Clock Frequency	V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V	2 5.5 7	4 11 14		MHz MHz MHz
t _{THL} or t _{TLH}	Transition Time	All Outputs V _{DD} = 5V V _{DD} = 10V V _{DD} = 15V		100 50 40	200 100 80	ns ns ns
C _{IN}	Average Input Capacitance	Any Input		5.0	7.5	pF
C _{PD}	Power Dissipation Capacity	(Note 4)		95		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 table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

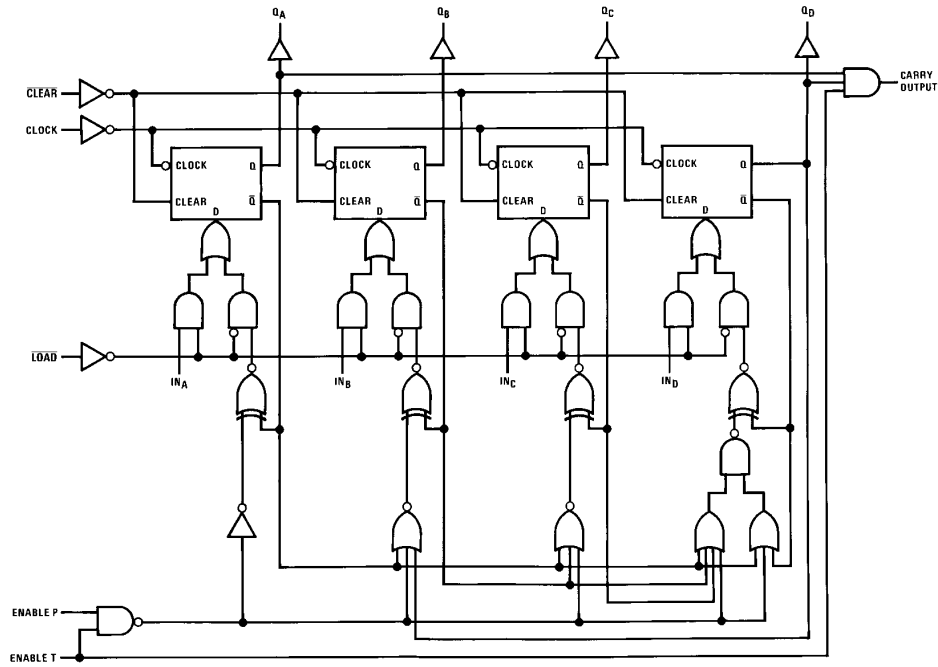
Note 2: V_{SS} = 0V unless otherwise specified.

Note 3: I_{OH} and I_{OL} are tested one output at a time.

Note 4: C_{PD} determines the no load AC power consumption of any CMOS device. For complete explanation see 54C/74C Family Characteristics application note, AN-90.

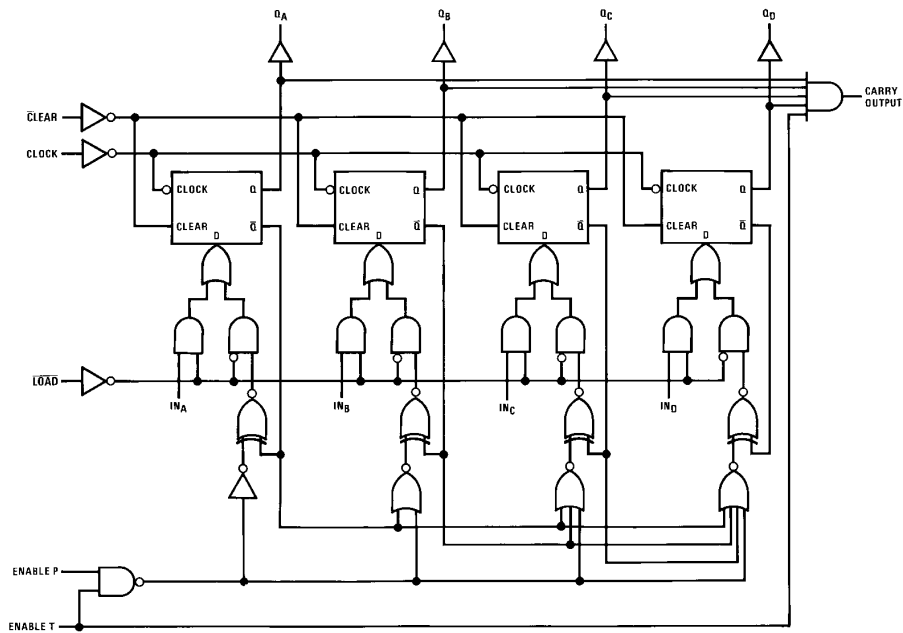
Logic Diagram

CD40160B, CD40162B Clear is Synchronous for the CD40162B



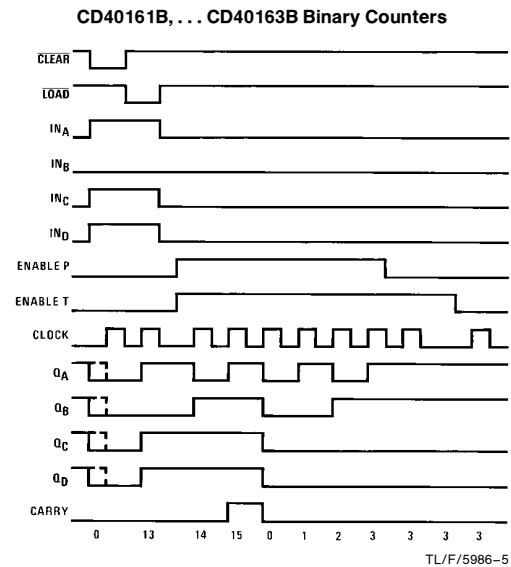
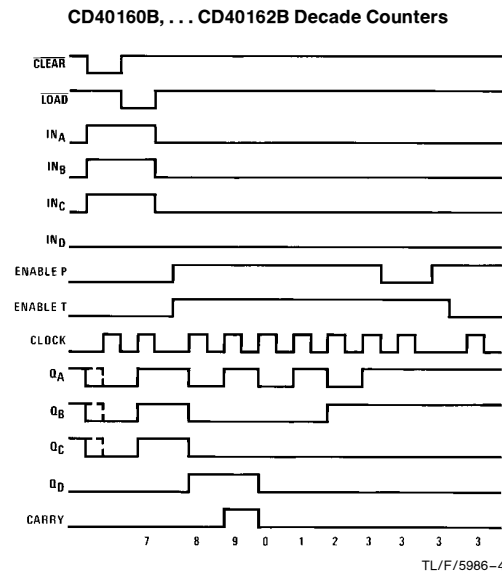
TL/F/5986-2

CD40161B, CD40163B Clear is Synchronous for the CD40163B

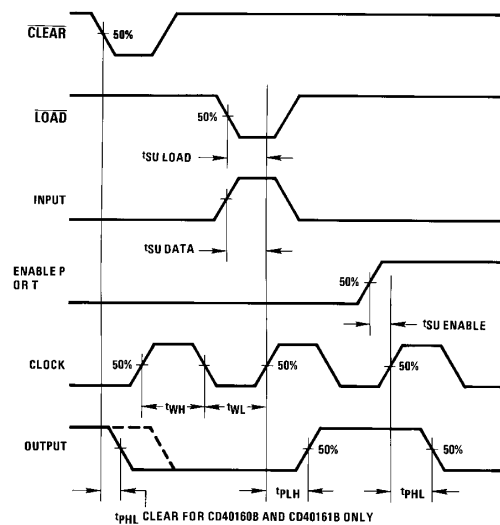


TL/F/5986-3

Logic Waveforms



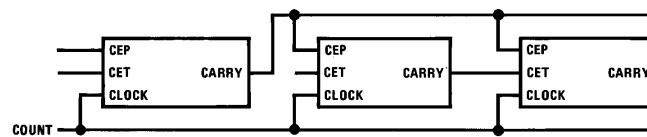
Switching Time Waveforms



Note 1: All input pulses are from generators having the following characteristics: $t_r = t_f = 20$ ns, $PRR \leq 1$ MHz, duty cycle $\leq 50\%$, $Z_{OUT} \approx 50\Omega$.

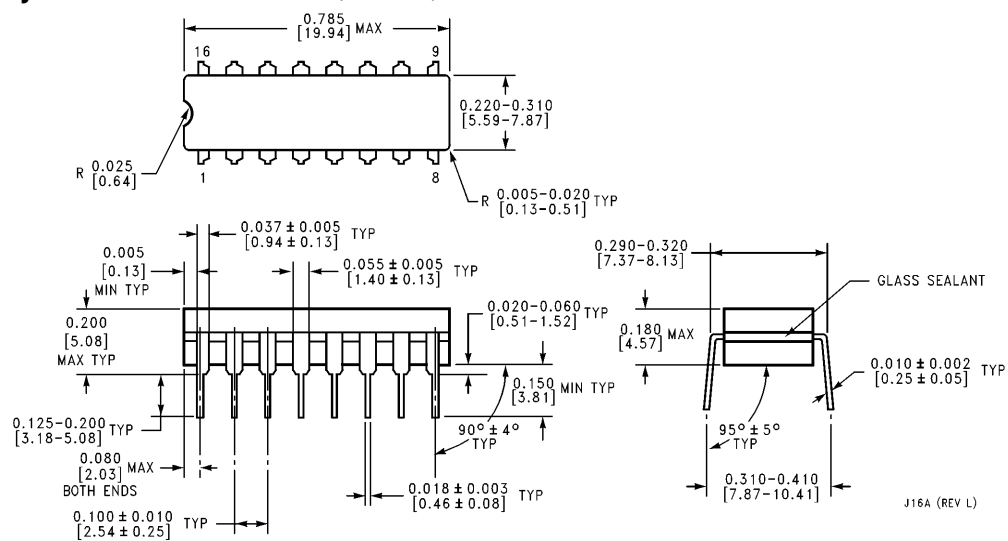
Note 2: All times are measured from 50% to 50%.

Cascading Packages



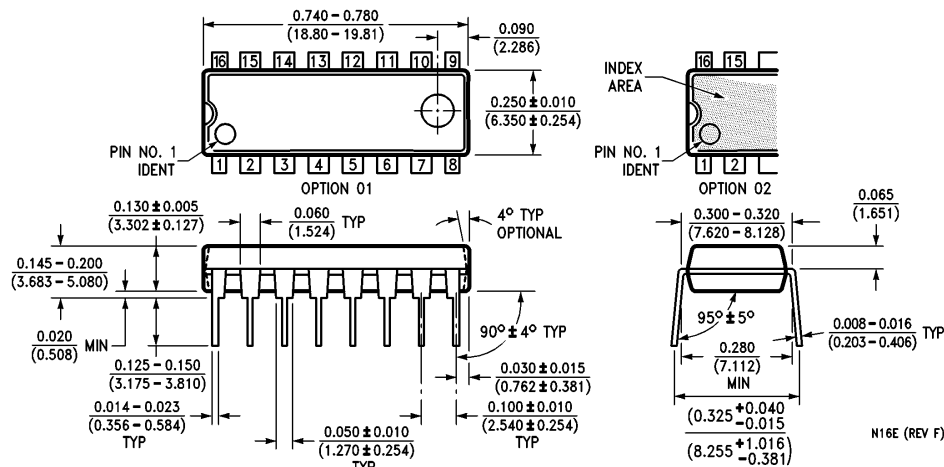


Physical Dimensions inches (millimeters)



Ceramic Dual-In-Line Package (J)
Order Number CD40160BMJ, CD40160BCJ, CD40161BMJ,
CD40161BCJ, CD40162BMJ, CD40162BCJ, CD40163BMJ or CD40163BCJ
NS Package Number J16A

Physical Dimensions inches (millimeters) (Continued)



Molded Dual-In-Line Package (N)
Order Number CD40160BMN, CD40160BCN, CD40161BMN,
CD40161BCN, CD40162BMN, CD40162BCN, CD41063BMN or CD40163BCN
NS Package Number N16E

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



National Semiconductor Corporation
 1111 West Bardin Road
 Arlington, TX 76017
 Tel: 1(800) 272-9959
 Fax: 1(800) 737-7018

National Semiconductor Europe
 Fax: (+49) 0-180-530 85 86
 Email: cnjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 13th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
 Tel: 81-043-299-2309
 Fax: 81-043-299-2408