

# CD40160B, CD40161B, CD40162B, CD40163B Types

## CMOS Synchronous Programmable 4-Bit Counters

High-Voltage Types (20-Volt Rating)

**CD40160B** – Decade with Asynchronous Clear

**CD40161B** – Binary with Asynchronous Clear

**CD40162B** – Decade with Synchronous Clear

**CD40163B** – Binary with Synchronous Clear

■ CD40160B, CD40161B, CD40162B, and CD40163B are 4-bit synchronous programmable counters. The CLEAR function of the CD40162B and CD40163B is synchronous and a low level at the CLEAR input sets all four outputs low on the next positive CLOCK edge. The CLEAR function of 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, LOAD, or ENABLE inputs. A low level at the LOAD input disables the counter and causes the output to agree with the setup data after the next CLOCK pulse regardless of the conditions of the ENABLE inputs.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a carry output (C<sub>OUT</sub>). Counting is enabled when both PE and TE inputs are high. The TE input is fed forward to enable C<sub>OUT</sub>. This enabled output produces a positive output pulse with a

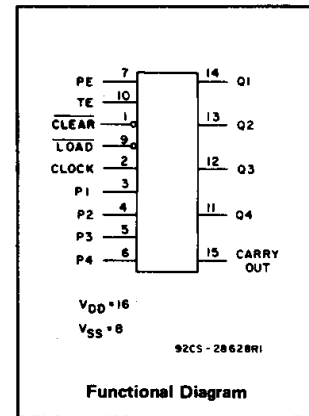
### Features:

- Internal look-ahead for fast counting
- Carry output for cascading
- Synchronously programmable
- Clear asynchronous input (CD40160B, CD40161B)
- Clear synchronous input (CD40162B, CD40163B)
- Synchronous load control input
- Low-power TTL compatibility
- Standardized, symmetrical output characteristics
- 100% tested for quiescent current at 20 V
- Maximum input current of 1 μA at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- Noise margin (over full package-temperature range): 1 V at V<sub>DD</sub> = 5 V  
2 V at V<sub>DD</sub> = 10 V 2.5 V at V<sub>DD</sub> = 15 V
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

duration approximately equal to the positive portion of the Q1 output. This positive overflow carry pulse can be used to enable successive cascaded stages. Logic transitions at the PE or TE inputs may occur when the clock is either high or low.

The CD40160B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix). The CD40161B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

The CD40160B through CD40163B types are functionally equivalent to and pin-compatible with the TTL counter series 74LS160 through 74LS163 respectively.



### Applications:

- Programmable binary and decade counting
- Counter control/timers
- Frequency dividing

### MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V <sub>DD</sub> )	
Voltages referenced to V <sub>SS</sub> Terminal)	-0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5V to V <sub>DD</sub> +0.5V
DC INPUT CURRENT, ANY ONE INPUT	±10mA
POWER DISSIPATION PER PACKAGE (P <sub>D</sub> ):	
For T <sub>A</sub> = -55°C to +100°C	500mW
For T <sub>A</sub> = +100°C to +125°C	Derate Linearly at 12mW/°C to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR T <sub>A</sub> = FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	100mW
OPERATING-TEMPERATURE RANGE (T <sub>A</sub> )	-55°C to +125°C
STORAGE TEMPERATURE RANGE (T <sub>stg</sub> )	-65°C to +150°C
LEAD TEMPERATURE (DURING SOLDERING):	
At distance 1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s max	+285°C

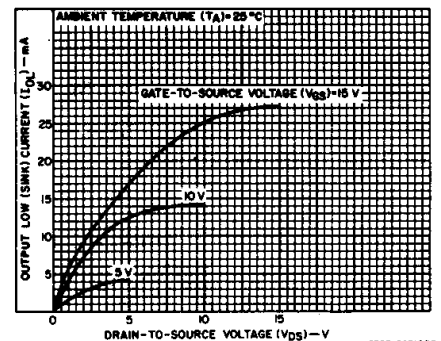


Fig. 1— Typical output low (sink) current characteristics.

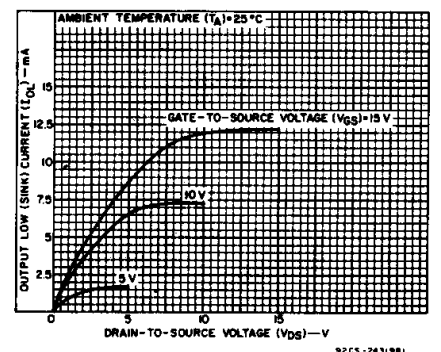


Fig. 2— Minimum output low (sink) current characteristics.

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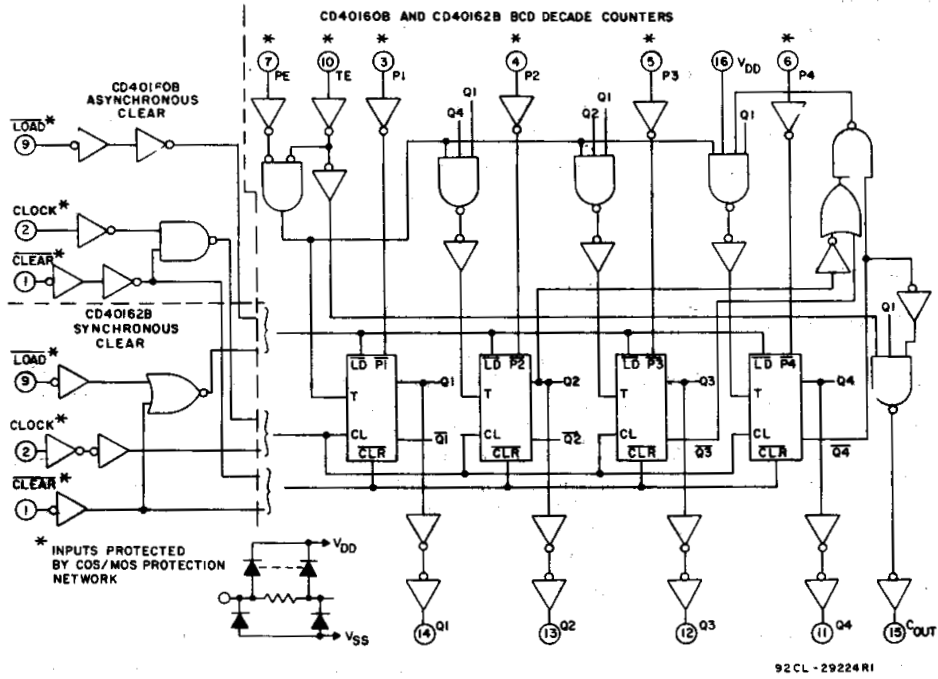


Fig. 3— Logic diagrams for CD40160B and CD40162B BCD decade counters.

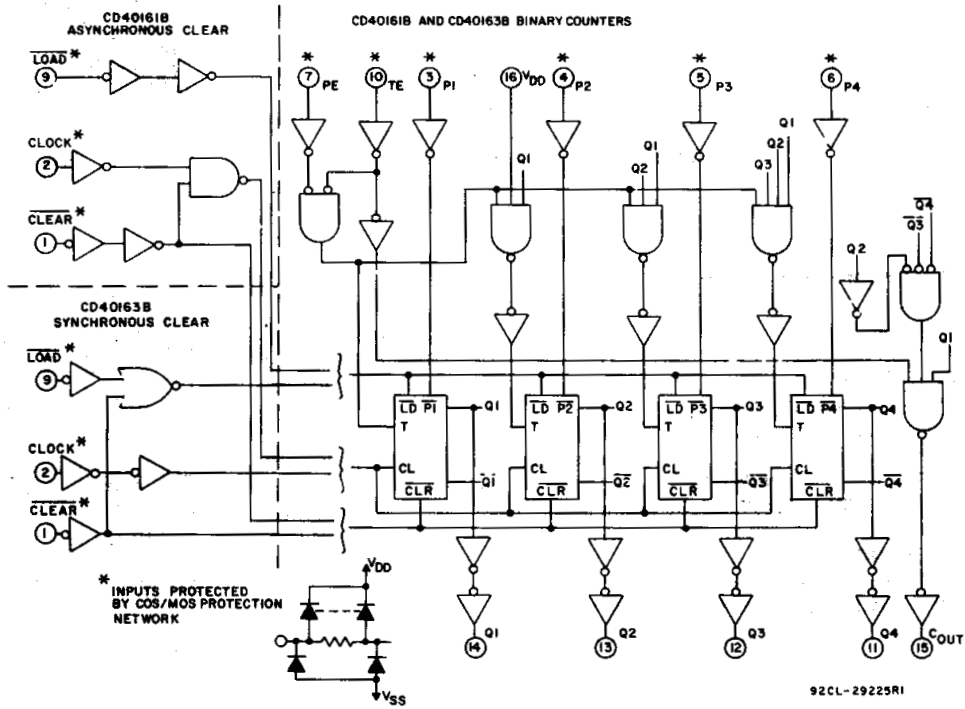


Fig. 4— Logic diagrams for CD40161B and CD40163B binary counters.

## CD40160B, CD40161B, CD40162B, CD40163B Types

**RECOMMENDED OPERATING CONDITIONS** at  $T_A = 25^\circ\text{C}$ , Except as Noted  
 For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	$V_{DD}$ (V)	LIMITS		UNITS
		MIN.	MAX.	
Supply Voltage Range (Full $T_A$ = Full Package-Temperature Range)	—	3	18	V
Setup Time: $t_{SU}$ Data to Clock	5	240	—	ns
	10	90	—	
	15	60	—	
Load to Clock	5	240	—	ns
	10	90	—	
	15	60	—	
PE or TE to Clock	5	340	—	ns
	10	140	—	
	15	100	—	
Clear to Clock (CD40162B, CD40163B)	5	340	—	ns
	10	140	—	
	15	100	—	
All Hold Times, $t_H$	5	0	—	ns
	10	0	—	
	15	0	—	
Clear Removal Time, $t_{rem}$ (CD40160B, CD40161B)	5	200	—	ns
	10	100	—	
	15	70	—	
Clear Pulse Width, $t_{WL}$ (CD40160B, CD40161B)	5	170	—	ns
	10	70	—	
	15	50	—	
Clock Input Frequency, $f_{CL}$	5	—	2	MHz
	10	—	5.5	
	15	—	8	
Clock Pulse Width, $t_W$	5	170	—	ns
	10	70	—	
	15	50	—	
Clock Rise or Fall Time, $t_{rCL}$ or $t_{fCL}$	5	—	200	$\mu\text{s}$
	10	—	70	
	15	—	15	

**TRUTH TABLE**

CLOCK	$\overline{\text{CLR}}$	$\overline{\text{LOAD}}$	PE	TE	OPERATION
	1	0	X	X	PRESET
	1	1	0	X	NC
	1	1	X	0	NC
	1	1	1	1	COUNT
X	0	X	X	X	RESET (CD40160B, CD40161B)
	0	X	X	X	RESET (CD40162B, CD40163B)
	1	X	X	X	NC (CD40162B, CD40163B)

1 = HIGH LEVEL    0 = LOW LEVEL    X = DON'T CARE    NC = NO CHANGE

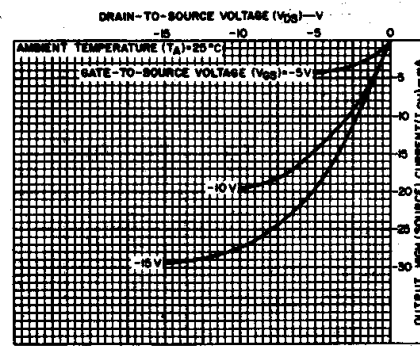


Fig. 5— Typical output high (source) current characteristics.

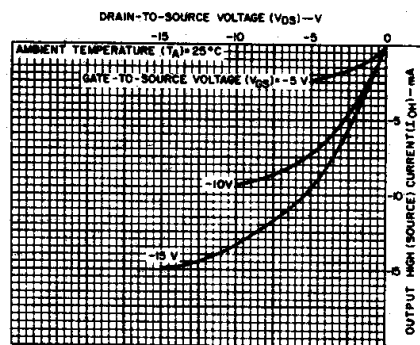


Fig. 6— Minimum output high (source) current characteristics.

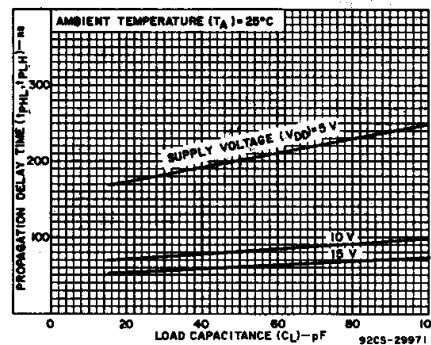


Fig. 7— Typical propagation delay time as a function of load capacitance (CLOCK to Q).

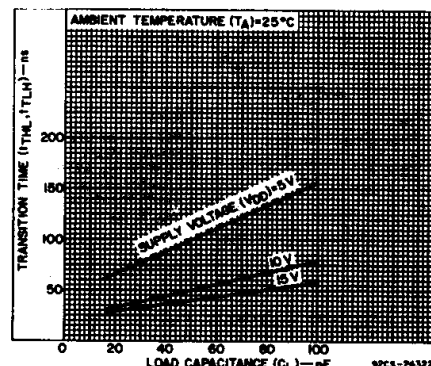


Fig. 8— Typical transition time as a function of load capacitance.

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## STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	-55	-40	+85	+125	+25			
								Min.	Typ.	Max.	
Quiescent Device Current, I <sub>DD</sub> Max.	—	0,5	5	5	5	150	150	—	0,04	5	μA
	—	0,10	10	10	10	300	300	—	0,04	10	
	—	0,15	15	20	20	600	600	—	0,04	20	
	—	0,20	20	100	100	3000	3000	—	0,08	100	
Output Low (Sink) Current, I <sub>OL</sub> Min.	0,4	0,5	5	0,64	0,61	0,42	0,36	0,51	1	—	mA
	0,5	0,10	10	1,6	1,5	1,1	0,9	1,3	2,6	—	
	1,5	0,15	15	4,2	4	2,8	2,4	3,4	6,8	—	
Output High (Source) Current, I <sub>OH</sub> Min.	4,6	0,5	5	-0,64	-0,61	-0,42	-0,36	-0,51	-1	—	mA
	2,5	0,5	5	-2	-1,8	-1,3	-1,15	-1,6	-3,2	—	
	9,5	0,10	10	-1,6	-1,5	-1,1	-0,9	-1,3	-2,6	—	
	13,5	0,15	15	-4,2	-4	-2,8	-2,4	-3,4	-6,8	—	
Output Voltage: Low-Level, V <sub>OL</sub> Max.	—	0,5	5	0,05				—	0	0,05	V
	—	0,10	10	0,05				—	0	0,05	
	—	0,15	15	0,05				—	0	0,05	
Output Voltage: High-Level, V <sub>OH</sub> Min.	—	0,5	5	4,95				4,95	5	—	V
	—	0,10	10	9,95				9,95	10	—	
	—	0,15	15	14,95				14,95	15	—	
Input Low Voltage, V <sub>IL</sub> Max.	0,5,4,5	—	5	1,5				—	—	1,5	V
	1,9	—	10	3				—	—	3	
	1,5,13,5	—	15	4				—	—	4	
Input High Voltage, V <sub>IH</sub> Min.	0,5,4,5	—	5	3,5				3,5	—	—	V
	1,9	—	10	7				7	—	—	
	1,5,13,5	—	15	11				11	—	—	
Input Current, I <sub>IN</sub> Max.	—	0,18	18	±0,1	±0,1	±1	±1	—	±10 <sup>-5</sup>	±0,1	μA

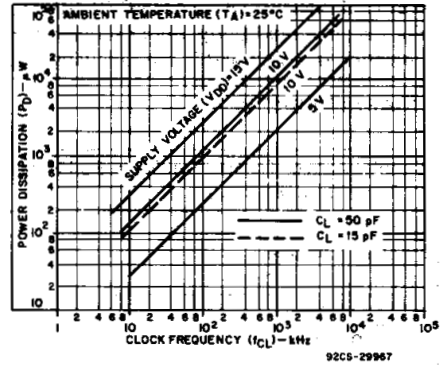


Fig. 9— Typical power dissipation as a function of CLOCK frequency.

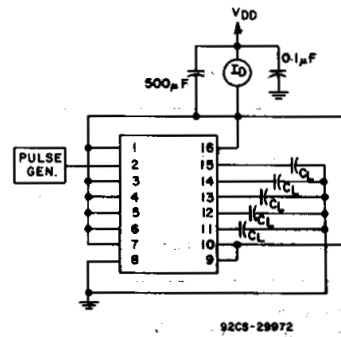


Fig. 10— Dynamic power dissipation test circuit.

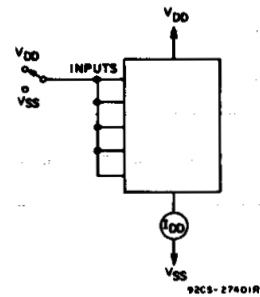


Fig. 11— Quiescent-device-current test circuit.

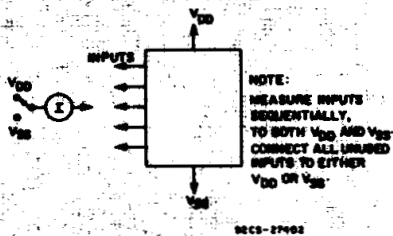


Fig. 12— Input-current test circuit.

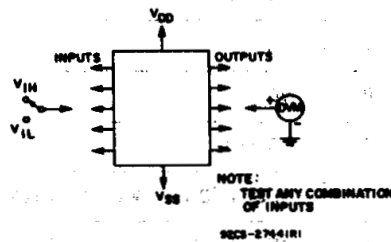


Fig. 13— Input-voltage test circuit.

## TERMINAL ASSIGNMENT

CLEAR	1	16	V <sub>DD</sub>
CLOCK	2	15	CARRY OUT
P1	3	14	Q1
P2	4	13	Q2
P3	5	12	Q3
P4	6	11	Q4
P5	7	10	TE
V <sub>SS</sub>	8	9	LOAD

TOP VIEW

# CD40160B, CD40161B, CD40162B, CD40163B Types

DYNAMIC ELECTRICAL CHARACTERISTICS at  $T_A = 25^\circ\text{C}$ ;  
 Input  $t_r, t_f = 20 \text{ ns}$ ,  $C_L = 50 \text{ pF}$ ,  $R_L = 200 \text{ k}\Omega$

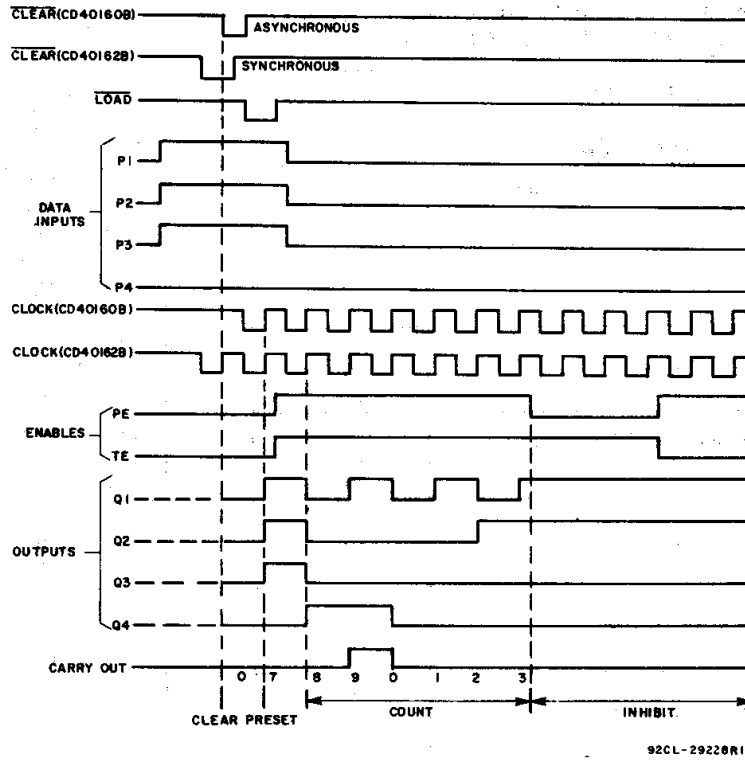
CHARACTERISTIC	TEST CONDITIONS $V_{DD}$ (V)	LIMITS ALL TYPES*			UNITS
		Min.	Typ.	Max.	
<b>CLOCK OPERATION</b>					
Propagation Delay Time, $t_{PHL}, t_{PLH}$ Clock to Q	5	—	200	400	ns
	10	—	80	160	
	15	—	60	120	
Clock to $C_{OUT}$	5	—	225	450	ns
	10	—	95	190	
	15	—	70	140	
TE to $C_{OUT}$	5	—	125	250	ns
	10	—	55	110	
	15	—	40	80	
Minimum Setup Time, $t_{SU}$ Data to Clock	5	—	120	240	ns
	10	—	45	90	
	15	—	30	60	
Load to Clock	5	—	120	240	ns
	10	—	45	90	
	15	—	30	60	
PE to TE to Clock	5	—	170	340	ns
	10	—	70	140	
	15	—	50	100	
Minimum Hold Time, $t_H$	5	—	—	0	ns
	10	—	—	0	
	15	—	—	0	
Transition Time, $t_{THL}, t_{TLH}$	5	—	100	200	ns
	10	—	50	100	
	15	—	40	80	
Minimum Clock Pulse Width, $t_W$	5	—	85	170	ns
	10	—	35	70	
	15	—	25	50	
Maximum Clock Frequency, $f_{CL}$	5	2	3	—	MHz
	10	5.5	8.5	—	
	15	8	12	—	
Maximum Clock Rise or Fall Time, $t_r, t_f, t_{rCL}, t_{fCL}$	5	200	—	—	$\mu\text{s}$
	10	70	—	—	
	15	15	—	—	
<b>CLEAR OPERATION</b>					
Propagation Delay Time, $t_{PHL}$ (CD40160B, CD40161B) Clear to Q	5	—	250	500	ns
	10	—	110	220	
	15	—	80	160	
Minimum Setup Time, $t_{SU}$ (CD40162B, CD40163B) Clear to Clock	5	—	170	340	ns
	10	—	70	140	
	15	—	50	100	
Minimum Hold Time, $t_H$ (CD40162B, CD40163B) Clear to Clock	5	—	—	0	ns
	10	—	—	0	
	15	—	—	0	
Minimum Clear Removal Time, $t_{rem}$ (CD40160B, CD40161B)	5	—	100	200	ns
	10	—	50	100	
	15	—	35	70	
Minimum Clear Pulse Width, $t_{WL}$ (CD40160B, CD40161B)	5	—	85	170	ns
	10	—	35	70	
	15	—	25	50	

\* Except as noted.

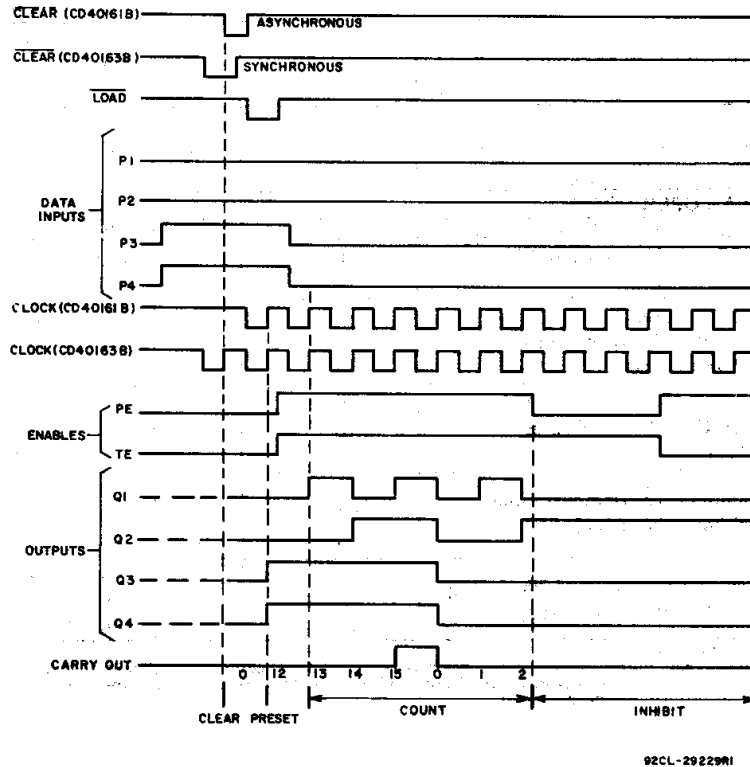
† If more than one unit is cascaded in the parallel clocked application,  $t_{rCL}$  should be made less than or equal to the sum of the fixed propagation delay at 50 pF and the transition time of the carry output driving stage for the estimated capacitive load.

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**Fig. 14—** Timing diagram for CD40160B, CD40162B.



**Fig. 15—** Timing diagram for CD40161B, CD40163B.

# CD40160B, CD40161B, CD40162B, CD40163B Types

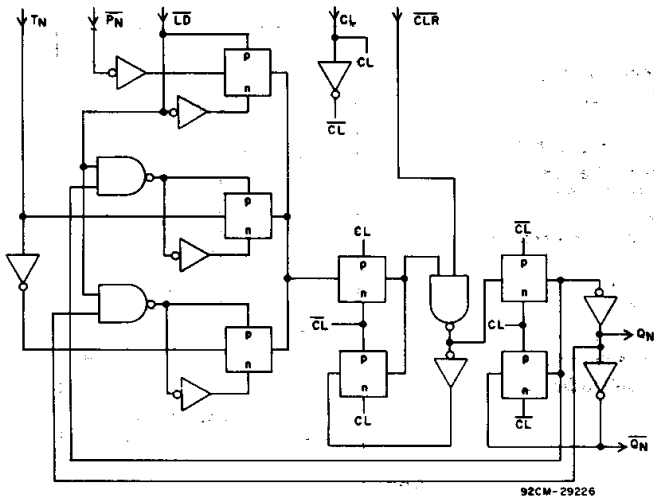


Fig. 16— Detail of flip-flops of CD40160B and CD40161B (asynchronous clear).

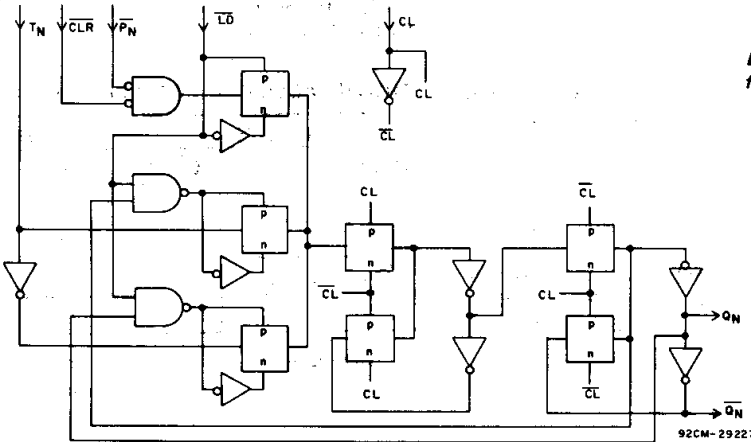
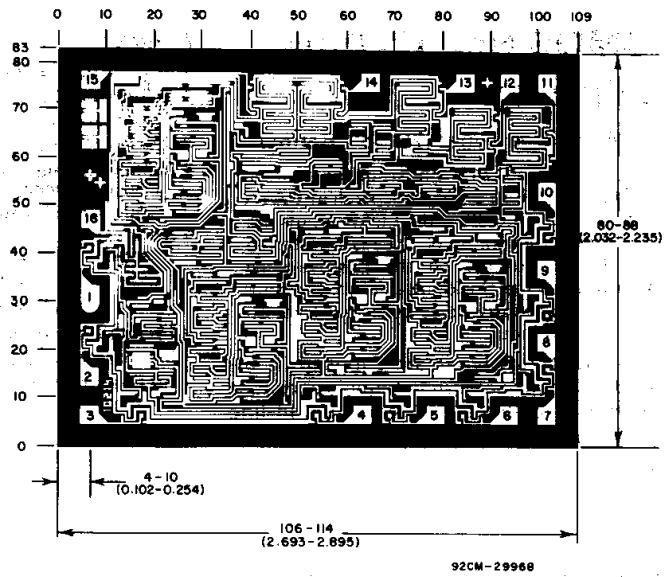


Fig. 17— Detail of flip-flops for CD40162B and CD40163B (synchronous clear).



Dimensions and pad layout for CD40160BH. Dimensions and pad layout for CD40161BH, CD40162BH, and CD40163BH are identical.

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

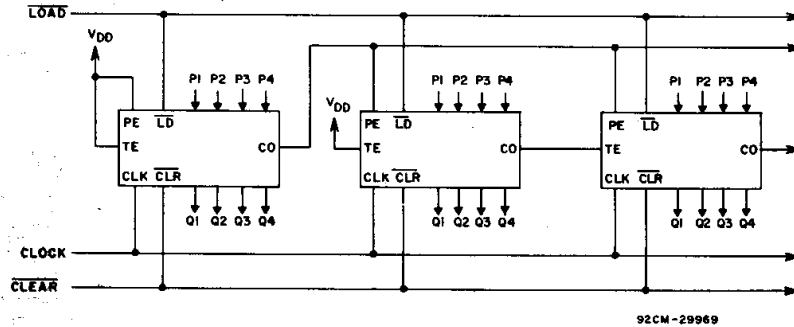


Fig. 18 — Cascaded counter packages in the parallel-clocked mode.

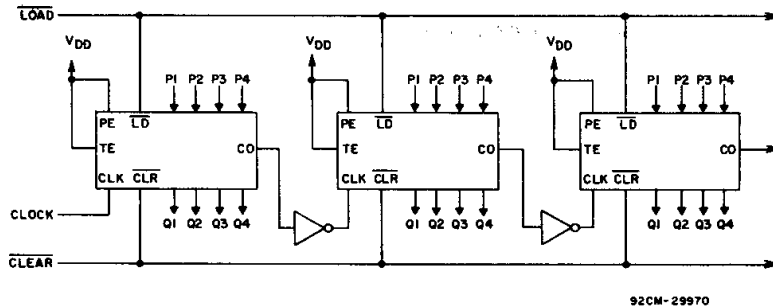


Fig. 19 — Cascaded counter packages in the ripple-clocked mode.

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**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
CD40160BF3A	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	N / A for Pkg Type
CD40161BE	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
CD40161BEE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
CD40161BF3A	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	N / A for Pkg Type
CD40161BNSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BNSRE4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BNSRG4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD40161BPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CD40161BNSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
CD40161BPWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD40161BNSR	SO	NS	16	2000	346.0	346.0	33.0
CD40161BPWR	TSSOP	PW	16	2000	346.0	346.0	29.0

J (R-GDIP-T\*\*)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package is hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
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