

## DM74S161 • DM74S163 Synchronous 4-Bit Binary Counters

### General Description

These synchronous, presettable counters feature an internal carry look-ahead for application in high-speed counting designs. They are 4-bit binary counters. The carry output is decoded by means of a NOR gate, thus preventing spikes during the normal counting mode of operation. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

These counters are fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a LOW level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable input.

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 ripple carry output. Both count-enable inputs (P and T) must be HIGH to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a HIGH-level output pulse with a duration approximately equal to the HIGH-level portion of the  $Q_A$  output. This HIGH-level overflow ripple carry pulse can be used to enable successive cascaded stages.

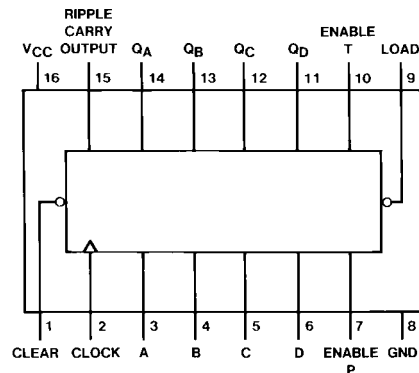
### Features

- Synchronously programmable
- Internal look-ahead for fast counting
- Carry output for n-bit cascading
- Synchronous counting
- Load control line
- Diode-clamped inputs

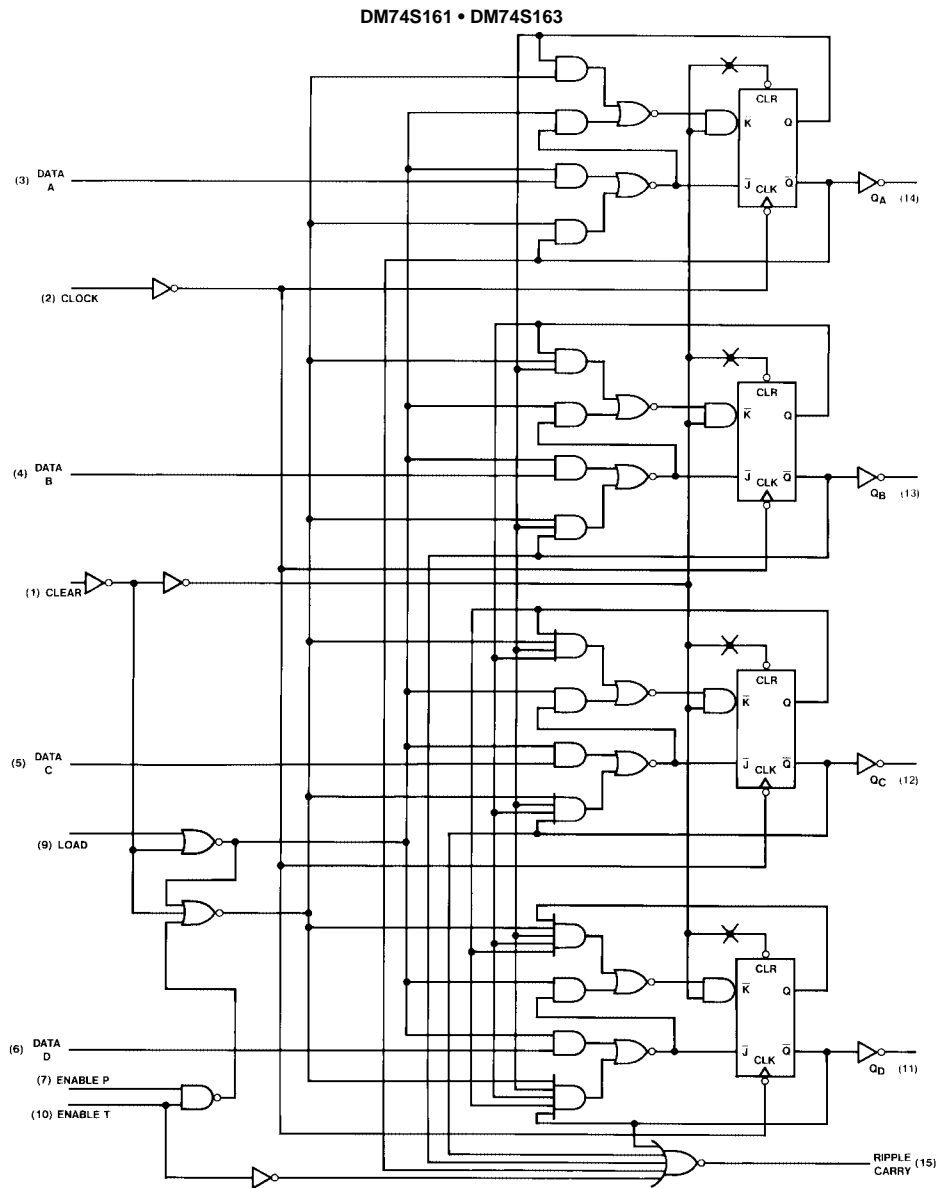
### Ordering Code:

Order Number	Package Number	Package Description
DM74S161N	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide
DM74S163N	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

### Connection Diagram

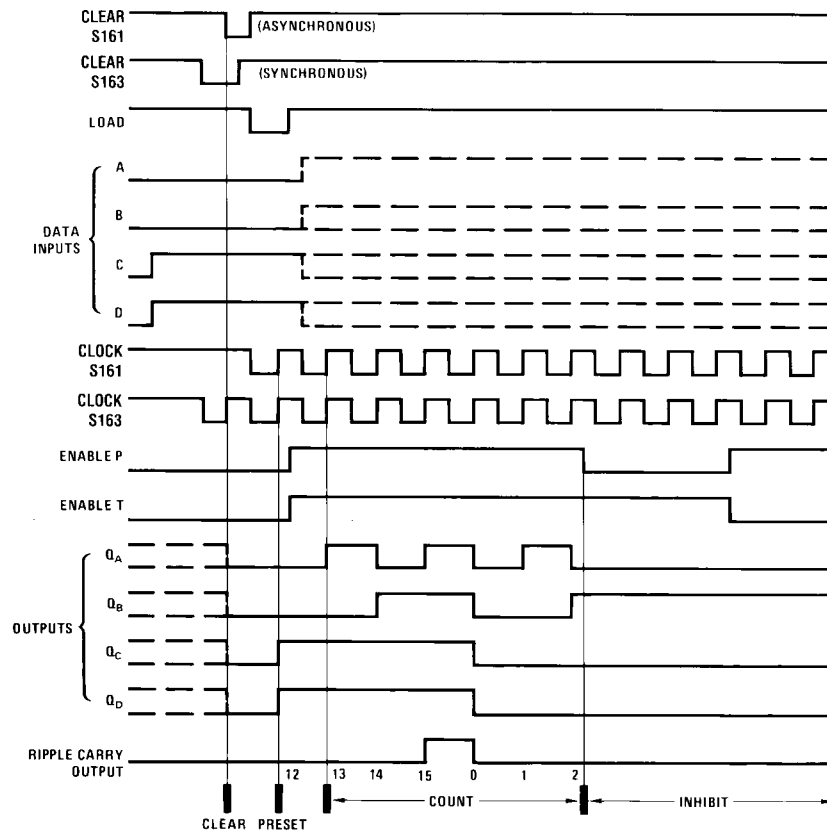


Logic Diagram



✱ S161 option

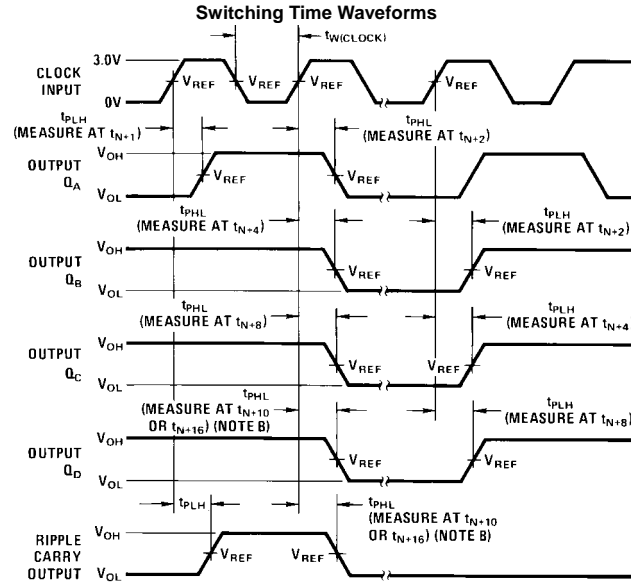
### Timing Diagram



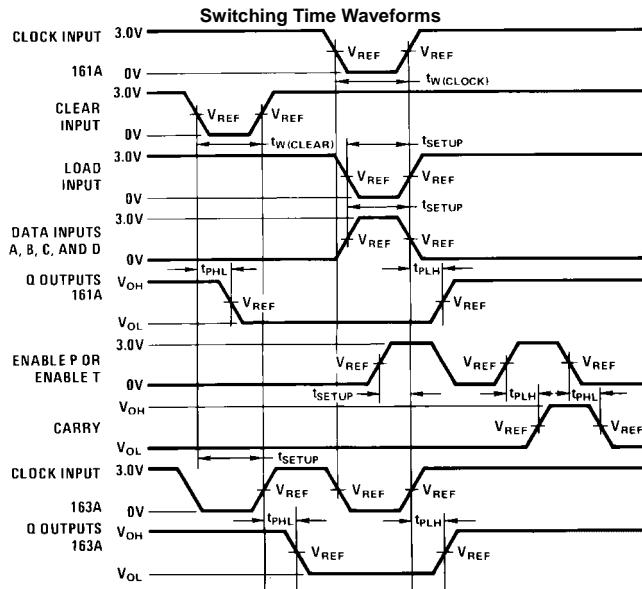
Sequence:

1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen, fourteen, fifteen, zero, one and two
4. Inhibit

## Parameter Measurement Information



- Note A:** The input pulses are supplied by generators having the following characteristics:  
 PRR  $\leq$  1 MHz, duty cycle  $\leq$  50%,  $Z_{OUT} = 50\Omega$ . For DM74S161/163,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns. Vary PRR to measure  $f_{MAX}$ .
- Note B:** Outputs  $Q_D$  and carry are tested at  $t_h + 16$  for DM74S161, SM74S163 where  $t_h$  is the bit time when all outputs are LOW
- Note C:**  $V_{REF} = 1.5V$ .



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- Note B:** Enable P and enable T setup times are measured at  $t_h + 0$ .
- Note C:**  $V_{REF} = 1.5V$ .

**Absolute Maximum Ratings**(Note 1)

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature Range	0°C to +70°C
Storage Temperature Range	-65°C to +150°C

**Note 1:** The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Recommended Operating Conditions**

Symbol	Parameter	Min	Nom	Max	Units
V <sub>CC</sub>	Supply Voltage	4.75	5	5.25	V
V <sub>IH</sub>	HIGH Level Input Voltage	2			V
V <sub>IL</sub>	LOW Level Input Voltage			0.8	V
I <sub>OH</sub>	HIGH Level Output Current			-1	mA
I <sub>OL</sub>	LOW Level Output Current			20	mA
f <sub>CLK</sub>	Clock Frequency (Note 2)	0		40	MHz
	Clock Frequency (Note 3)	0		35	
t <sub>W</sub>	Pulse Width (Note 2)	Clock	10		ns
		Clear (Note 5)	10		
	Pulse Width (Note 3)	Clock	12		
		Clear (Note 5)	12		
t <sub>SU</sub>	Setup Time (Note 2)	Data	4		ns
		Enable P or T	12		
		Load	14		
		Clear (Note 4)	14		
	Setup Time (Note 3)	Data	5		
		Enable P or T	14		
		Load	16		
		Clear (Note 4)	16		
t <sub>H</sub>	Hold Time (Note 2)	Data	3		ns
		Others	0		
	Hold Time (Note 3)	Data	5		
		Others	2		
t <sub>REL</sub>	Load or Clear Release Time (Note 2)	12			ns
	Load or Clear Release Time (Note 3)	14			
T <sub>A</sub>	Free Air Operating Temperature	0		70	°C

**Note 2:** C<sub>L</sub> = 15 pF, R<sub>L</sub> = 280Ω, T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V.

**Note 3:** C<sub>L</sub> = 50 pF, R<sub>L</sub> = 280Ω, T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V.

**Note 4:** Applies only to the DM74S163 which has synchronous clear inputs.

**Note 5:** Applies only to the DM74S161 which has asynchronous clear inputs.

## Electrical Characteristics

over recommended operating free air temperature (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 6)	Max	Units
$V_I$	Input Clamp Voltage	$V_{CC} = \text{Min}$ , $I_I = -18 \text{ mA}$			-1.2	V
$V_{OH}$	HIGH Level Output Voltage	$V_{CC} = \text{Min}$ , $I_{OH} = \text{Max}$ $V_{IL} = \text{Max}$ , $V_{IH} = \text{Min}$	2.7	3.4		V
$V_{OL}$	LOW Level Output Voltage	$V_{CC} = \text{Min}$ , $I_{OL} = \text{Max}$ $V_{IH} = \text{Min}$ , $V_{IL} = \text{Max}$			0.5	V
$I_I$	Input Current @ Max Input Voltage	$V_{CC} = \text{Max}$ , $V_I = 5.5\text{V}$			1	mA
$I_{IH}$	LOW Level Input Current	$V_{CC} = \text{Max}$ $V_I = 2.7\text{V}$	CLK, Data		50	$\mu\text{A}$
			Others	-10	-200	
$I_{IL}$	LOW Level Input Current	$V_{CC} = \text{Max}$ $V_I = 0.5\text{V}$	Enable T		-4	mA
			Others		-2	
$I_{OS}$	Short Circuit Output Current	$V_{CC} = \text{Max}$ (Note 7)	-40		-100	mA
$I_{CC}$	Supply Current	$V_{CC} = \text{Max}$		95	160	mA

**Note 6:** All typicals are at  $V_{CC} = 5\text{V}$ ,  $T_A = 25^\circ\text{C}$ .

**Note 7:** Not more than one output should be shorted at a time, and the duration should not exceed one second.

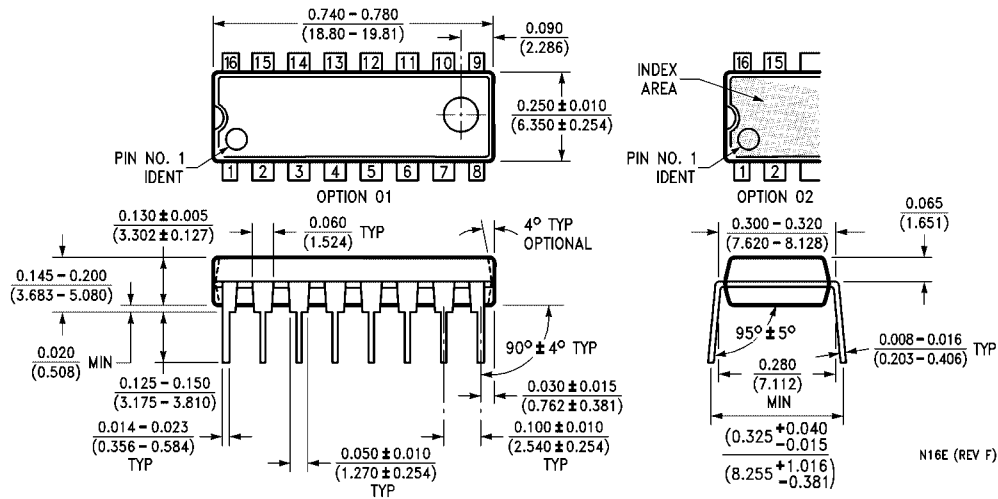
## Switching Characteristics

at  $V_{CC} = 5\text{V}$  and  $T_A = 25^\circ\text{C}$

Symbol	Parameter	From (Input) To (Output)	$R_L = 280\Omega$				Units
			$C_L = 15 \text{ pF}$		$C_L = 50 \text{ pF}$		
			Min	Max	Min	Max	
$f_{MAX}$	Maximum Clock Frequency		40		35		MHz
$t_{PLH}$	Propagation Delay Time LOW-to-HIGH Level Output	Clock to Ripple Carry		25		25	ns
$t_{PHL}$	Propagation Delay Time HIGH-to-LOW Level Output	Clock to Ripple Carry		25		28	ns
$t_{PLH}$	Propagation Delay Time LOW-to-HIGH Level Output	Clock to Any Q		15		15	ns
$t_{PHL}$	Propagation Delay Time HIGH-to-LOW Level Output	Clock to Any Q		15		18	ns
$t_{PLH}$	Propagation Delay Time LOW-to-HIGH Level Output	Enable T to Ripple Carry		15		18	ns
$t_{PHL}$	Propagation Delay Time HIGH-to-LOW Level Output	Enable T to Ripple Carry		15		18	ns
$t_{PHL}$	Propagation Delay Time HIGH-to-LOW Level Output (Note 8)	Clear to Any Q		20		24	ns

**Note 8:** Propagation delay for clearing is measured from clear input for the DM74S161 and from the clock input transition for the DM74S163.

**Physical Dimensions** inches (millimeters) unless otherwise noted



**16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide Package Number N16E**

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