

DM54S161/DM74S161, DM54S163/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 blocked 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.

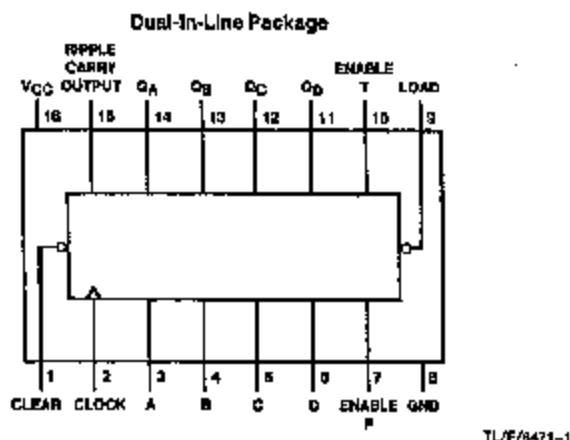
These counters are fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable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

Connection Diagram



Order Number DM54S161J, DM54S163J, DM54S161W,
DM74S161N, or DM74S163N
See NS Package Number J16A, N16E or W16A

Absolute Maximum Ratings (Note)

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

Supply Voltage 7V

Input Voltage 5.5V

Operating Free Air Temperature Range

DM54S -55°C to +125°C

DM74S 0°C to +70°C

Storage Temperature Range -65°C to +150°C

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Note: 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" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Recommended Operating Conditions See Section 1 for Test Waveforms and Output Load

Symbol	Parameter	DM54S161/163			DM74S161/163			Units
		Min	Norm	Max	Min	Norm	Max	
V _{CC}	Supply Voltage	4.5	5	6.5	4.75	5	5.25	V
V _{IH}	High Level Input Voltage	2			2			V
V _{IL}	Low Level Input Voltage			0.6			0.6	V
I _{OH}	High Level Output Current			-1			-1	mA
I _{OL}	Low Level Output Current			20			20	mA
f _{CLK}	Clock Frequency (Note 1)	0		40	0		40	MHz
	Clock Frequency (Note 2)	0		35	0		35	
t _w	Pulse Width (Note 1)	Clock	10		10			ns
			10		10			
	Pulse Width (Note 2)	Clock	12		12			
			12		12			
t _{su}	Setup Time (Note 1)	Data	4		4			ns
		Enable P or T	12		12			
		Load	14		14			
		Clear (Note 3)	14		14			
	Setup Time (Note 2)	Data	5		5			
		Enable P or T	14		14			
		Load	16		16			
		Clear (Note 3)	16		16			
t _h	Hold Time (Note 1)	Data	3		3			ns
		Others	0		0			
	Hold Time (Note 2)	Data	5		5			
		Others	2		2			
t _{REL}	Load or Clear Release Time (Note 1)	12			12			ns
	Load or Clear Release Time (Note 2)	14			14			
T _A	Free Air Operating Temperature	-55		125	0		70	°C

Note 1: C_L = 16 pF, R_L = 200Ω, T_A = 25°C and V_{CC} = 5V.

Note 2: C_L = 60 pF, R_L = 200Ω, T_A = 25°C and V_{CC} = 5V.

Note 3: Applies only to the 'S163 which has synchronous clear inputs.

Note 4: Applies only to the 'S161 which has asynchronous clear inputs.

Electrical Characteristics over recommended operating free air temperature (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 1)	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	$V_{CC} = \text{Min}$ $I_{OH} = \text{Max}$ $V_{IL} = \text{Max}$ $V_{IH} = \text{Min}$	DM64	2.5	3.4	V
			DM74	2.7	3.4	
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}	High Level Input Current	$V_{CC} = \text{Max}$ $V_I = 2.7 \text{ V}$	CLK, Data		60	μA
			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 2)	DM64	-40	-100	mA
			DM74	-40	-100	
I_{CC}	Supply Current	$V_{CC} = \text{Max}$		95	160	mA

Switching Characteristics at $V_{CC} = 5 \text{ V}$ and $T_A = 25^\circ\text{C}$ (See Section 1 for Test Waveforms and Output Load)

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		36		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 3)	Clear to Any Q		20		24	ns

Note 1: All typicals are at $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ\text{C}$.

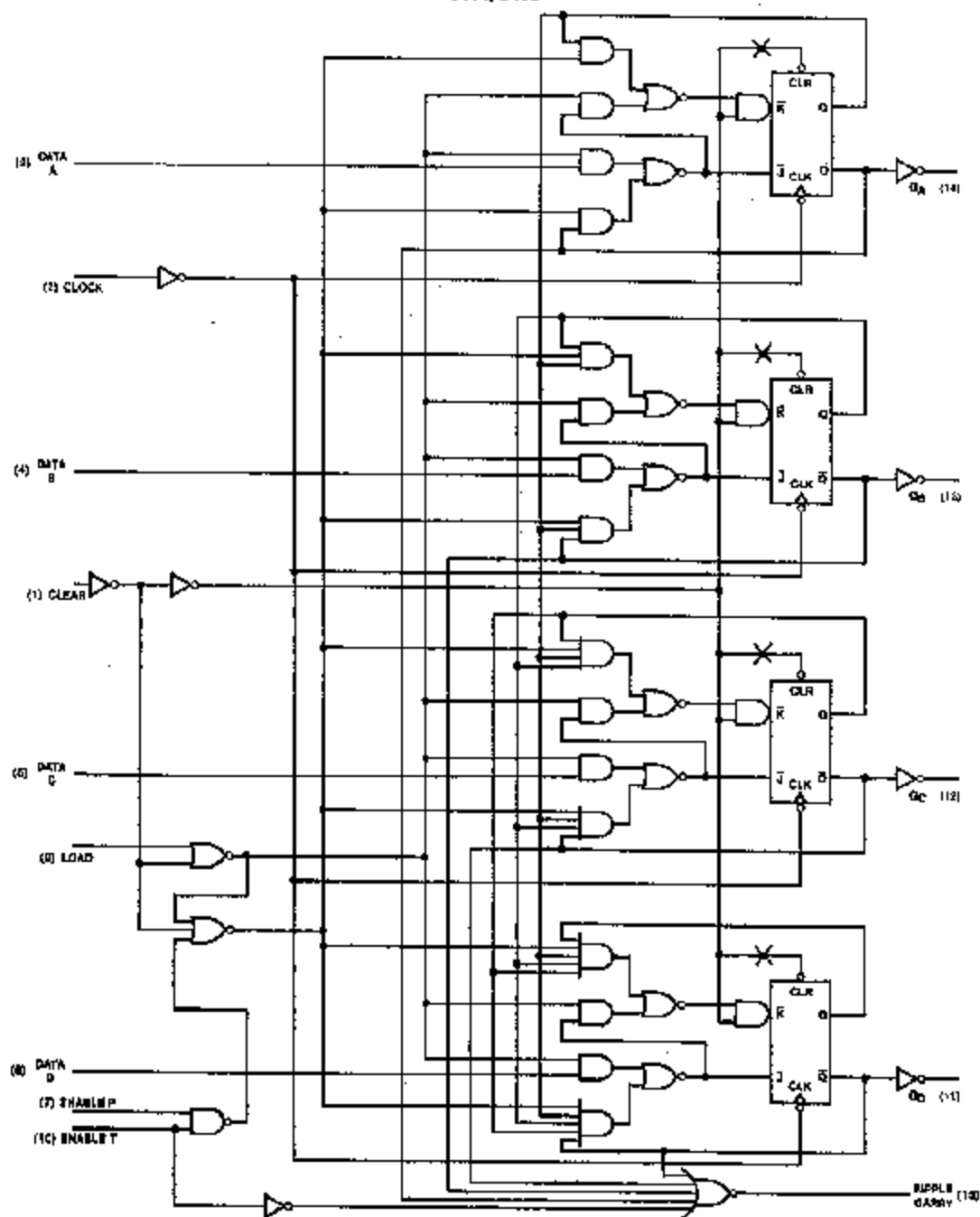
Note 2: Not more than one output should be shorted at a time, and the duration should not exceed one second.

Note 3: Propagation delay for clearing is measured from clear input for the '5161 and from the clock input transition for the '5163.

Logic Diagram

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9161, 9163



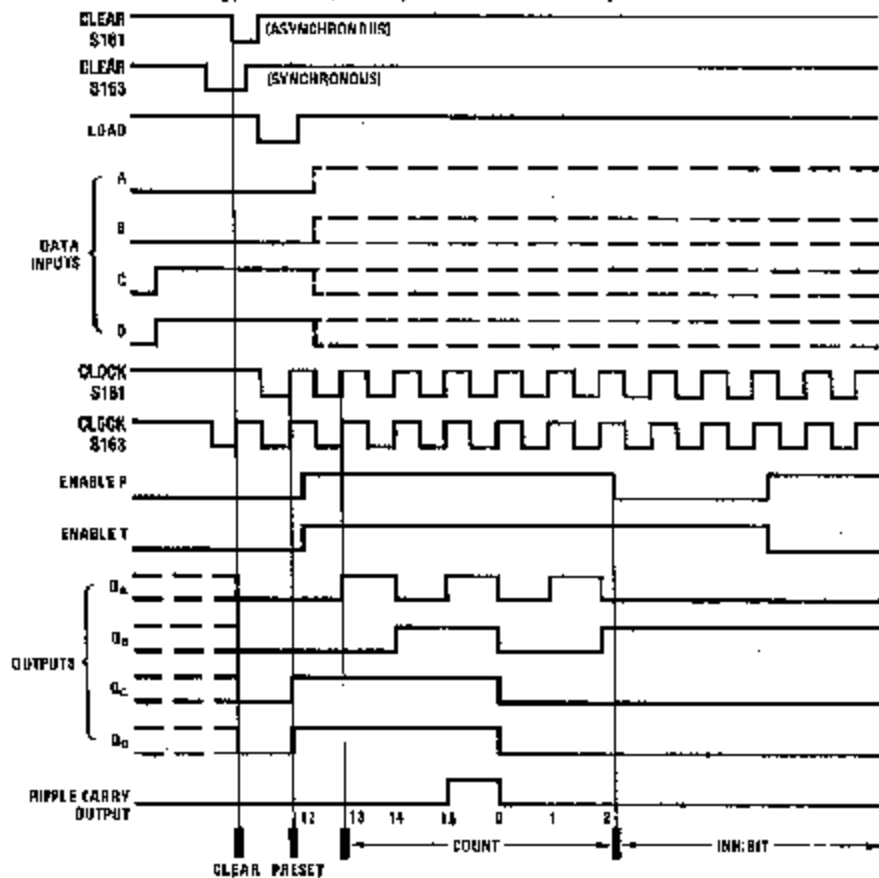
X 9164 option

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Timing Diagram

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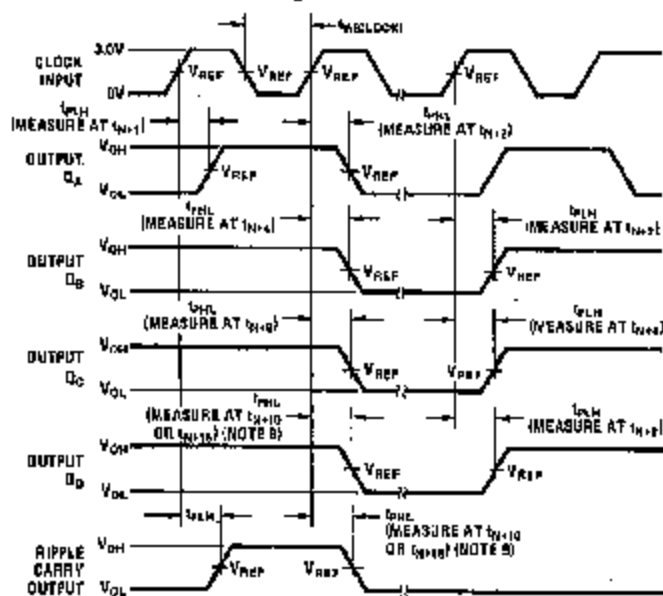
S161, S163 Synchronous Binary Counters Typical Clear, Preset, Count and Inhibit Sequences



U/F/8471-8

S161•S163

Switching Time Waveforms



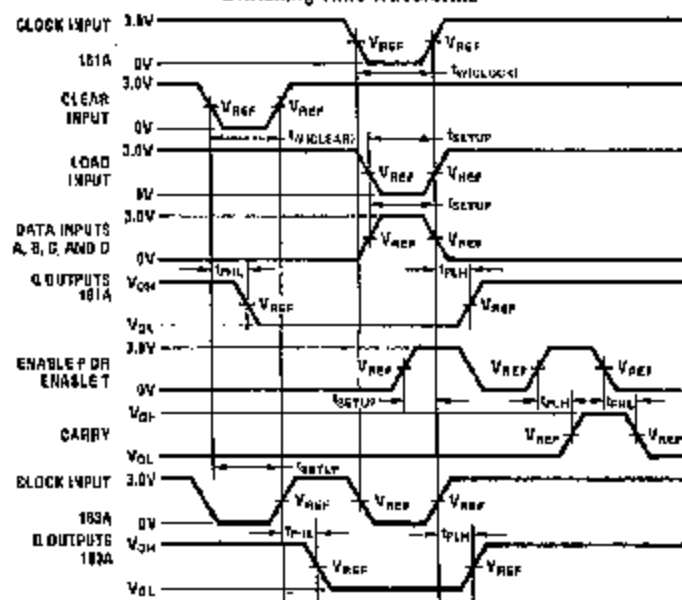
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Note A: The input pulses are supplied by generators having the following characteristics: PPR ≤ 1 MHz, duty cycle $\leq 50\%$, $Z_{out} \approx 50\Omega$. For 9181/183, $t_r \leq 2.5$ ns, $t_f \leq 2.5$ ns. Vary PPR to measure f_{MAX} .

Note B: Outputs Q_0 and carry are tested at $t_0 + 10$ for S161, 5163 where t_0 is the bit time when all outputs are low.

Note C: $V_{BE} = 1.6V$.

Switching Time Waveforms



TL/F/0471-5

Note A: The input pulses are supplied by generators having the following characteristics: $\text{PPF} \leq 1 \text{ kHz}$, duty cycle $\leq 60\%$, $Z_{\text{OUT}} = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$. Vary PPF to measure t_{MAX} .

Note B: Enable P and enable " setup times are measured at $t_r + 0$.

Note C: $V_{REF} = 1.5V$.