FAIRCHILD SEMICONDUCTOR™

February 1998

DM74AS161, 163
Synchronous Four-Bit Counter

General Description

These synchronous presettable counters feature an internal carry look ahead for application in high speed counting designs. The AS161 and AS163 are four-bit binary counters. The AS161 clear asynchronously, while the AS163 clear synchronously. The carry output is decoded to prevent spikes during normal counting mode of operation. Synchronous operation is provided by having all flip-flops clocked simultaneously so that outputs change coincident with each other when so instructed by 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 each be preset to either level. As presetting is synchronous, setting up a low level at the $\overline{\text{LOAD}}$ input disables the counter and causes the outputs to agree with set up data after the next clock pulse regardless of the levels of enable input. Low to high transitions at the $\overline{\text{LOAD}}$ input are perfectly acceptable regardless of the logic levels on the clock or enable inputs.

The AS161 clear function is asynchronous. A low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of clock, load or enable inputs. This counter is provided with a clear on power-up feature. The AS163 clear function is synchronous; and a low level at the clear input sets all four of the flip-flop outputs low after the next clock pulse, regardless of the levels of enable inputs. This synchronous clear allows the count length to be modified easily, as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to synchronously clear the counter to all low outputs. Low to high transitions at the clear input of the AS163 is also permissible regardless of the levels of logic on the clock, enable or load inputs.

The carry look ahead circuitry provides for cascading counters for n bit synchronous application without additional gating. Instrumental in accomplishing this function are two count-enable inputs (P and T) and a ripple carry output. Both count-enable inputs must be high to count. The T input 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 QA output. This high level overflow ripple carry pulse can be used to enable successive cascaded stages. High to low level transitions at the enable P or T inputs of the AS161 and AS163, may occur regardless of the logic level on the clock.

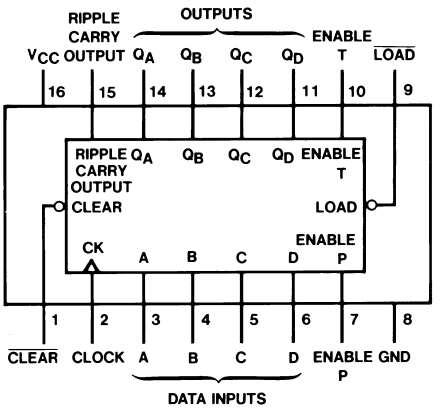
The AS161 and AS163 feature a fully independent clock circuit. Changes made to control inputs (enable P or T, or load) that will modify the operating mode will have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable set-up and hold times.

Features

- Switching specifications at 50 pF
- Switching specifications guaranteed over full temperature and V_{CC} range
- Advanced oxide-isolated, ion-implanted Schottky TTL process
- Functionally and pin-for-pin compatible with Schottky and low power Schottky TTL counterpart
- Improved AC performance over Schottky and low power Schottky counterparts
- Synchronously programmable
- Internal look ahead for fast counting
- Carry output for n-bit cascading
- Synchronous counting
- Load control line
- ESD inputs

Connection Diagram

Dual-In-Line Package



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Order Number DM74AS161N, M,
or DM74AS163N, M
See Package Number N16A, M16A

Absolute Maximum Ratings (Note 2)

Supply Voltage	7V
Input Voltage	7V
Operating Free Air Temperature Range	0˚C to +70˚C
Storage Temperature Range	−65˚C to +150˚C
Typical θ_{JA}	
N Package	71.5˚C/W
M Package	101.0˚C/W

Recommended Operating Conditions

Symbol	Parameter			DM74AS161 and 163			Units
				Min	Nom	Max	
V_{CC}	Supply Voltage			4.5	5	5.5	V
V_{IH}	High Level Input Voltage			2			V
V_{IL}	Low Level Input Voltage					0.8	V
I_{OH}	High Level Output Current					−2	mA
I_{OL}	Low Level Output Current					20	mA
f_{CLK}	Clock Frequency			0		75	MHz
t_{SU}	t_{setup}, Set-Up Time	Data; A, B, C, D		8			ns
		En P, En T		8			ns
		$\overline{LOAD}$		8			ns
		$\overline{CLEAR}$ (Only for 163)	Low	12			ns
			High	9			
	Set-up 1 (Only for AS161)	$\overline{CLEAR}$		8			ns
t_H	t_{hold}, Hold Time	Data; A, B, C, D		0			ns
		En P, En T		0			ns
		$\overline{LOAD}$		0			ns
		$\overline{CLEAR}$ (Only for 163)		0			ns
	Hold 0 (Only for 161)	$\overline{CLEAR}$		0			ns
t_{WCLK}	Width of Clock Pulse			6.7			ns
t_{WCLR}	Width of Clear Pulse, ('AS161 Low)			8			ns

Note 1: This product meets application requirements of 500 temperature cycles from −65˚C to +150˚C.

Note 2: *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.*

Electrical Characteristics

over recommended operating free air temperature rangeAll typical values are measured at V_{CC} = 5V, T_A = 25˚C

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{IK}	Input Clamp Voltage	V_{CC} = 4.5V, I_I = −18 mA				−1.2	V
V_{OH}	High Level Output Voltage	I_{OH} = −2 mA, V_{CC} = 4.5 to 5.5V		V_{CC} − 2			V
V_{OL}	Low Level Output Voltage	V_{CC} = 4.5V, I_{OL} = 20 mA			0.35	0.5	V
I_I	Input Current @ Max Input Voltage	V_{CC} = 5.5V, V_{IH} = 7V	$\overline{LOAD}$			0.3	mA
			ENT			0.2	
			Others			0.1	
I_{IH}	High Level Input Current	V_{CC} = 5.5V, V_{IH} = 2.7V	$\overline{LOAD}$			60	µA
			ENT			40	
			Others			20	

Electrical Characteristics (Continued)

over recommended operating free air temperature rangeAll typical values are measured at V_{CC} = 5V, T_A = 25˚C

Symbol	Parameter	Conditions		Min	Typ	Max	Units
I_{IL}	Low Level Input Current	V_{CC} = 5.5V, V_{IL} = 0.4V	$\overline{LOAD}$			−0.5	mA
			ENT			−1	
			Others			−0.5	
I_O (Note 3)	Output Drive Current	V_{CC} = 5.5V, V_O = 2.25V		−30		−112	mA
I_{CC}	Supply Current	V_{CC} = 5.5V			35	53	mA

Note 3: The output conditions have been chosen to produce a current that closely approximates one half of the true short circuit output current, I_{OS}.

Switching Characteristics

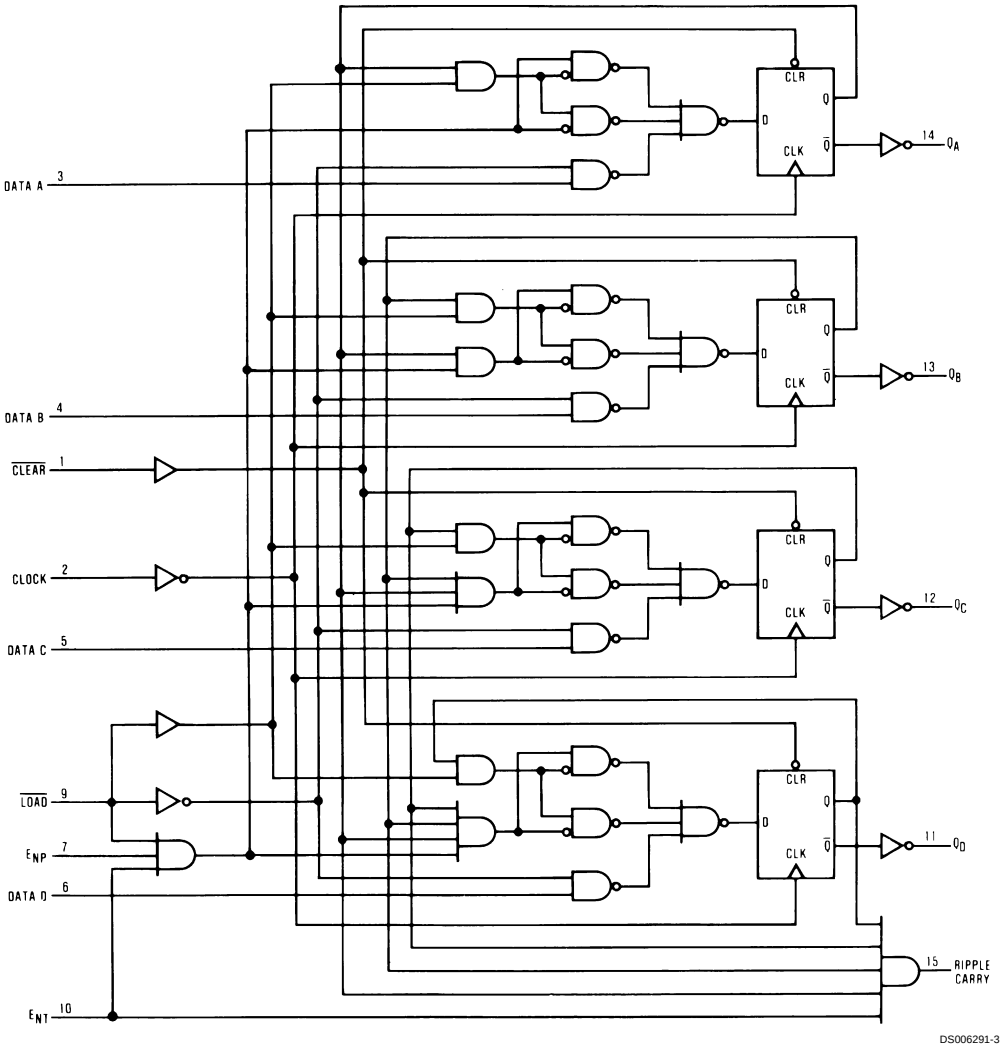
over recommended operating free air temperature range (Note 4)

Symbol	Parameter	Conditions	From	To	DM74AS161 and 163		Units
					Min	Max	
f_{MAX}	Max. Clock Freq.	V_{CC} = 4.5V to 5.5V, R_L = 500Ω, C_L = 50 pF			75		MHz
t_{PHL}	Propagation Delay Time High to Low Level Output		Clock	Ripple Carry	2	12.5	ns
t_{PLH}	Propagation Delay Time Low to High Level Output with Load High		Clock	Ripple Carry	1	8	ns
t_{PLH}	Propagation Delay Time Low to High Level Output with Load Low		Clock	Ripple Carry	3	16.5	ns
t_{PLH}	Propagation Delay Time Low to High Level Output		Clock	Any Q	1	7	ns
t_{PHL}	Propagation Delay Time High to Low Level Output		Clock	Any Q	2	13	ns
t_{PLH}	Propagation Delay Time Low to High Level Output		En T	Ripple Carry	1.5	9	ns
t_{PHL}	Propagation Delay Time High to Low Level Output		En T	Ripple Carry	1	8.5	ns
t_{PHL}	Propagation Delay Time High to Low Level Output		$\overline{CLEAR}$ (AS161)	Any Q	2	13	ns
t_{PHL}	Propagation Delay Time High to Low Level Output		$\overline{CLEAR}$ (AS161)	Ripple Carry	2	12.5	ns

Note 4: See Section 5 for test waveforms and output load.

Logic Diagrams

AS161



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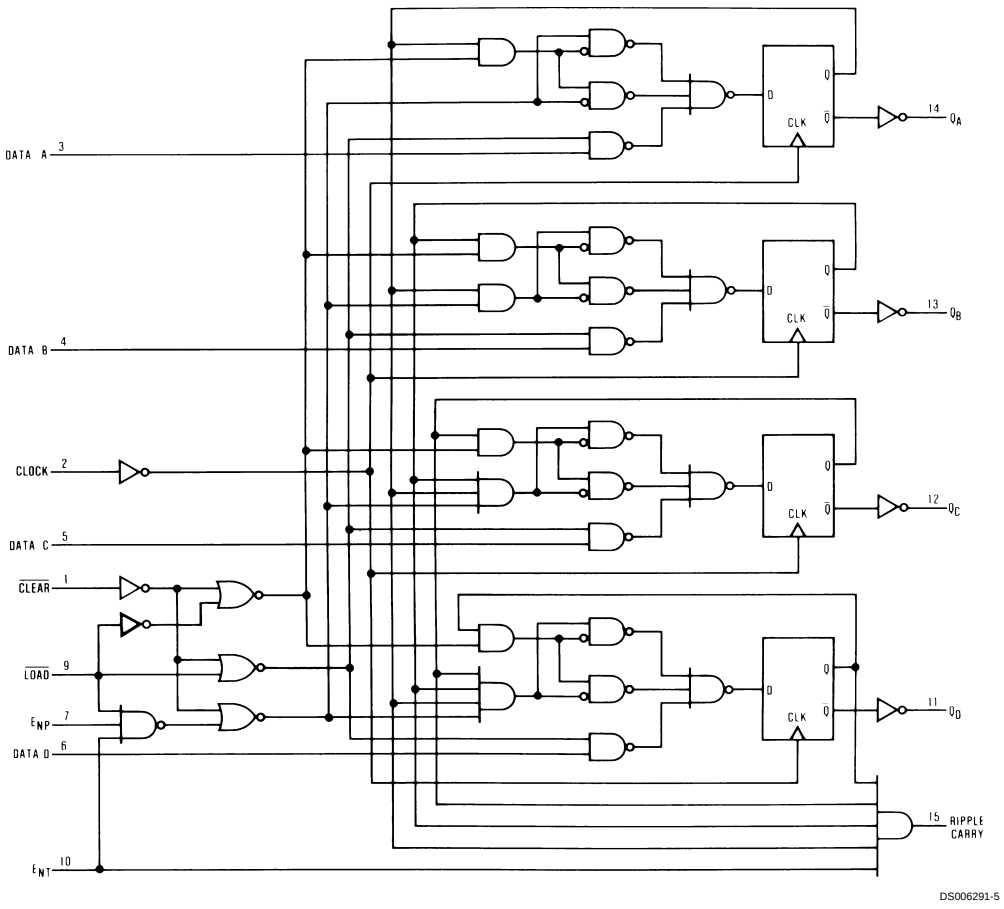
Logic Diagrams (Continued)

AS163



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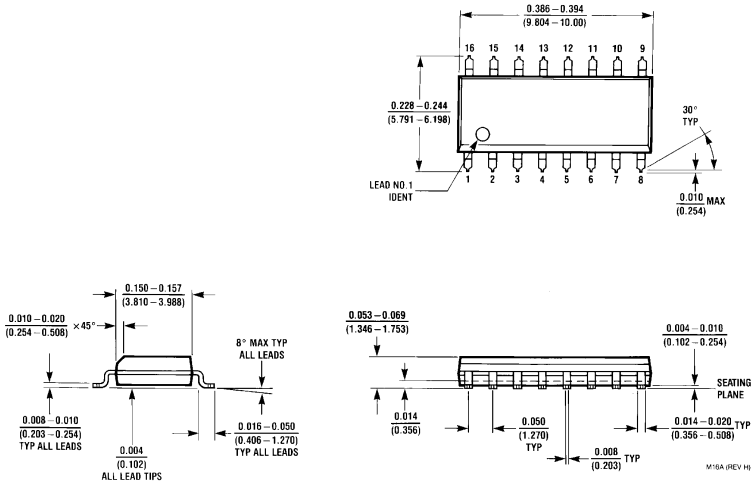
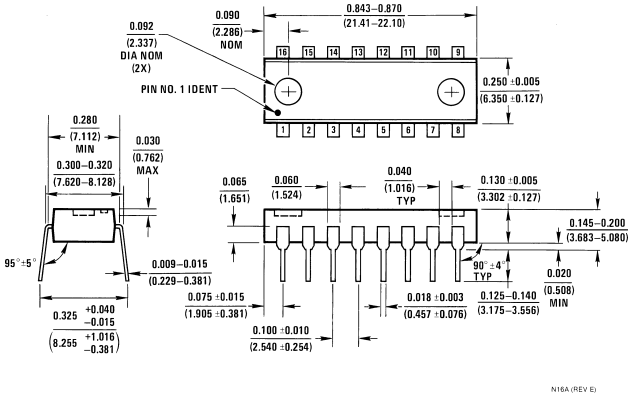
Physical Dimensions inches (millimeters) unless otherwise noted



S.O Package (M)
Order Number DM74AS161M or DM74AS163M
Package Number M16A



Molded Dual-In-Line Package (N)
Order Number DM74AS161N or DM74AS163N
Package Number N16A

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Fairchild Semiconductor Corporation
Americas
Customer Response Center
Tel: 1-888-522-5372

Fairchild Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 8 141-35-0
English Tel: +44 (0) 1 793-85-68-56
Italy Tel: +39 (0) 2 57 5631

Fairchild Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: +852 2737-7200
Fax: +852 2314-0061

National Semiconductor Japan Ltd.
Tel: 81-3-5620-6175
Fax: 81-3-5620-6179

www.fairchildsemi.com