

### **Rochester Electronics Manufactured Components**

Rochester branded components are manufactured using either die/wafers purchased from the original suppliers or Rochester wafers recreated from the original IP. All recreations are done with the approval of the OCM.

Parts are tested using original factory test programs or Rochester developed test solutions to guarantee product meets or exceed the OCM data sheet.

### **Quality Overview**

- ISO-9001
- AS9120 certification
- Qualified Manufacturers List (QML) MIL-PRF-35835
  - Class Q Military
  - Class V Space Level
- Qualified Suppliers List of Distributors (QSLD)
  - Rochester is a critical supplier to DLA and meets all industry and DLA standards.

Rochester Electronics, LLC is committed to supplying products that satisfy customer expectations for quality and are equal to those originally supplied by industry manufacturers.

The original manufacturer's datasheet accompanying this document reflects the performance and specifications of the Rochester manufactured version of this device. Rochester Electronics guarantees the performance of its semiconductor products to the original OEM specifications. 'Typical' values are for reference purposes only. Certain minimum or maximum ratings may be based on product characterization, design, simulation, or sample testing.

- Internal Look-Ahead for Fast Counting
- Carry Output for n-Bit Cascading
- Fully Synchronous Operation for Counting
- Package Options Include Plastic "Small Outline" Packages, Ceramic Chip Carriers, and Standard Plastic and Ceramic 300-mil DIPs
- Dependable Texas Instruments Quality and Reliability

**description**

These synchronous, presettable decade counters feature an internal carry look-ahead for application in high-speed counting designs. 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 that are normally associated with asynchronous (ripple clock) counters; however, counting spikes may occur on the ripple carry output (RCO). A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

The counters are fully programmable; that is, they may be preset to any number between 0 and 9. 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 inputs.

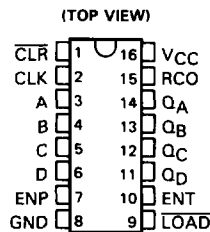
If one of these decade counters is preset to a number between 10 and 15 or assumes such an invalid state when power is applied, it will progress to the normal sequence within two counts as shown in the State Diagram.

The clear function for the 'F160A is asynchronous and a low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of the clock, load, or enable inputs.

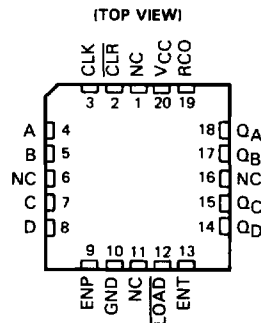
The clear function for the 'F162A is synchronous and a low level at the clear input sets all four of the flip-flop outputs low after the next low-to-high transition of the clock regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily by decoding the Q outputs for the maximum count desired. The active-low output of the gate used for decoding is connected to the clear input to synchronously clear the counter to 0000 (LLLL).

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 (ENP and ENT) must be high to count, and ENT is fed forward to enable the ripple carry output (RCO). RCO thus enabled will produce a high-level pulse while the count is 9 (HLLH). This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. Transitions at the ENP or ENT are allowed regardless of the level of the clock input.

**SN54F160A, SN54F162A . . . J PACKAGE  
SN74F160A, SN74F162A . . . D OR N PACKAGE**



**SN54F160A, SN54F162A . . . FK PACKAGE**



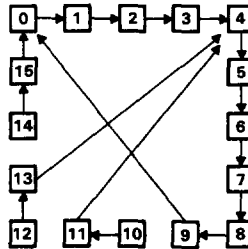
NC - No internal connection

**description (continued)**

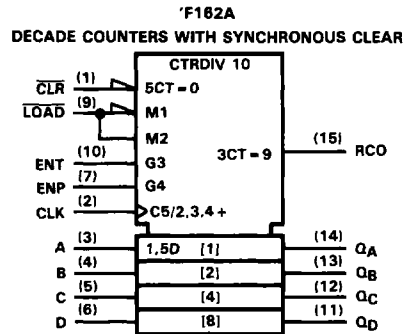
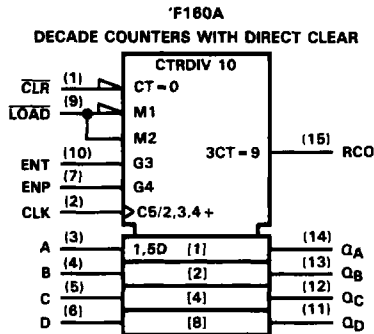
These counters feature a fully independent clock circuit. Changes at control inputs (ENP, ENT, or  $\overline{\text{LOAD}}$ ) that will modify the operating mode have no effect on the contents of the counter until clocking occurs. The function of the counter (whether enabled, disabled, loading, or counting) will be dictated solely by the conditions meeting the setup and hold times.

The SN54F160A and SN54F162A are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74F160A and SN74F162A are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

**state diagram**

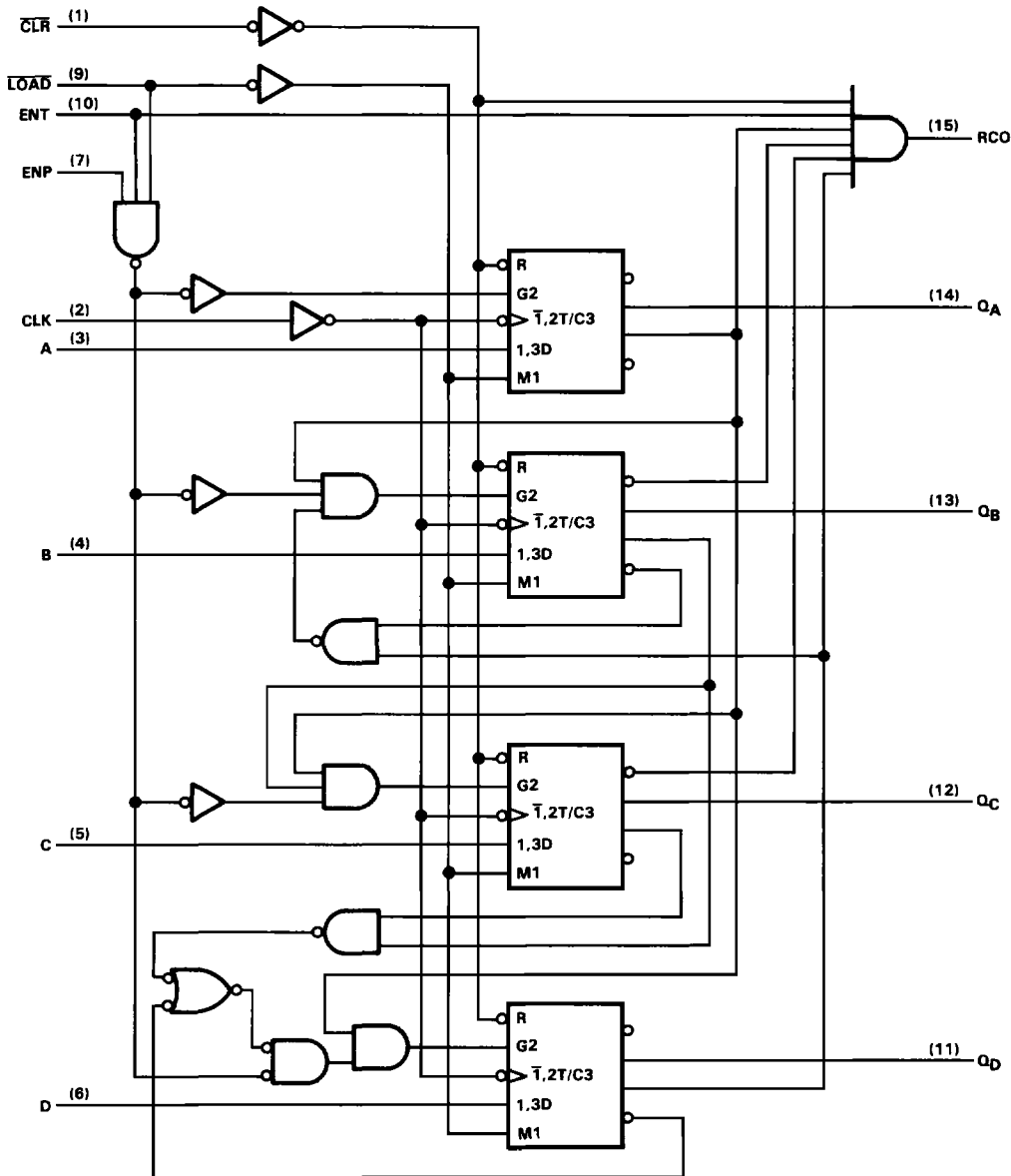


**logic symbols†**



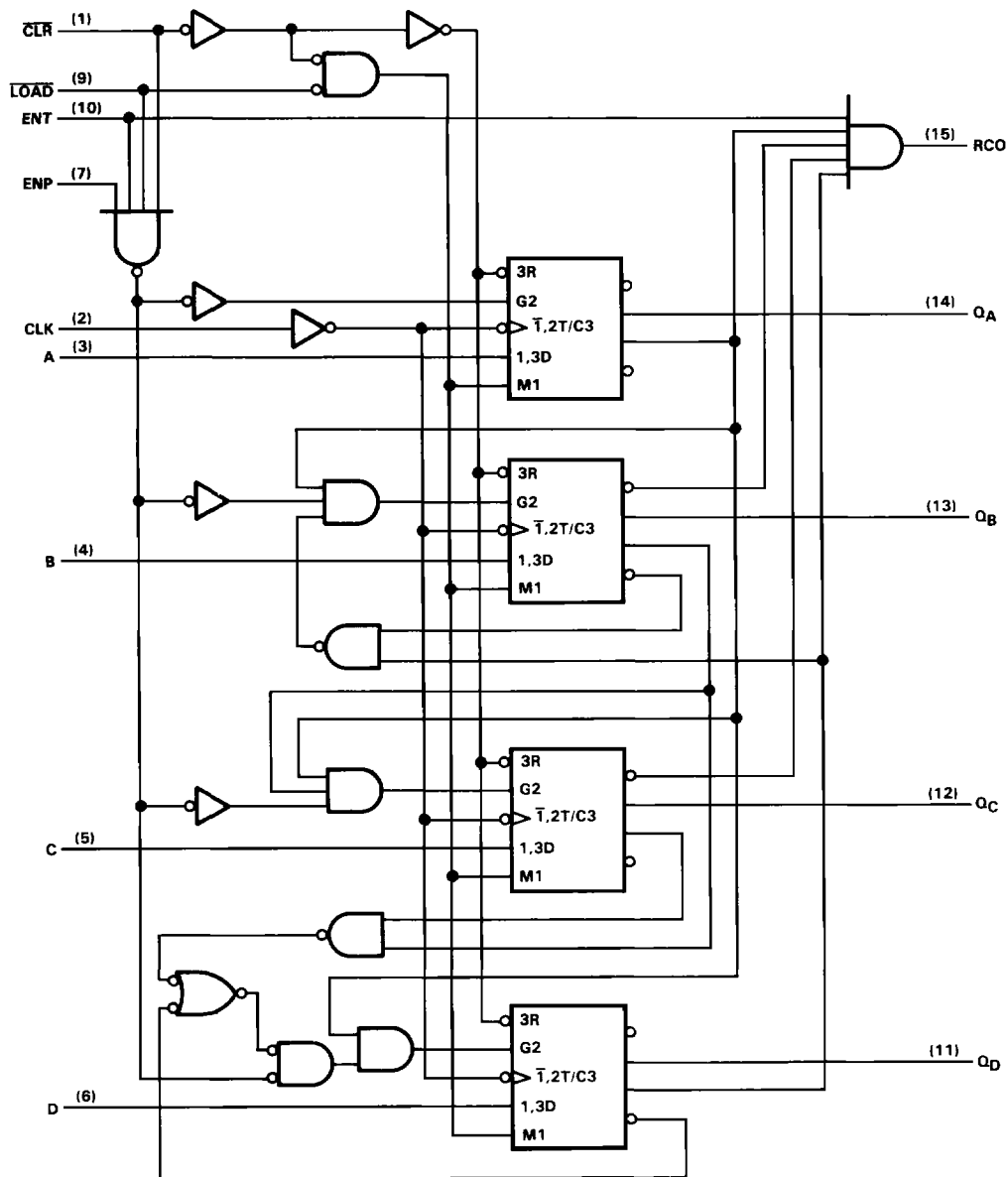
†These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for D, J, and N packages.

'F160A logic diagram (positive logic)



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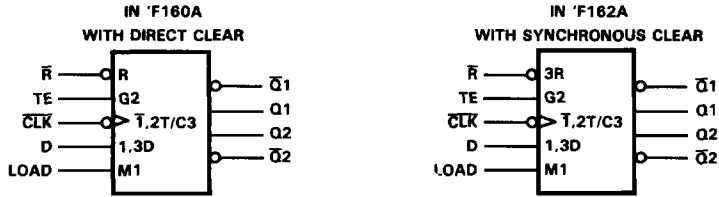
'F162A logic diagram (positive logic)



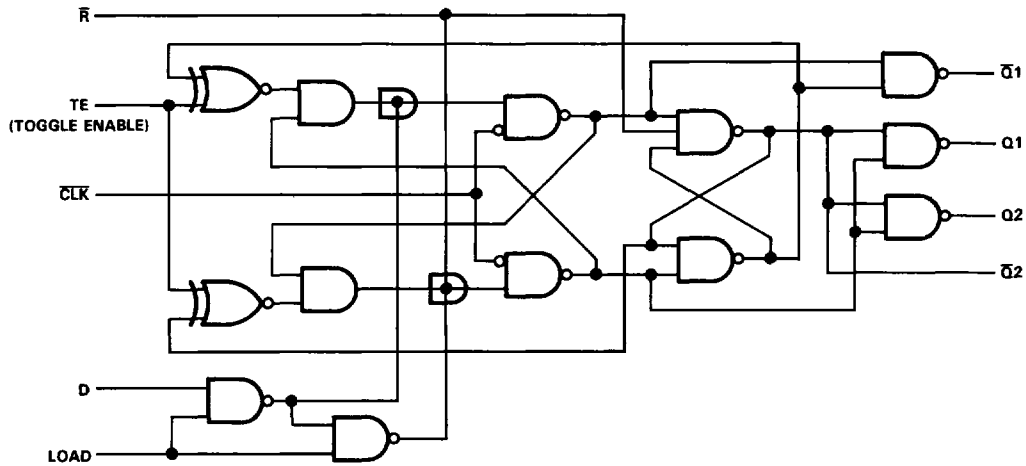
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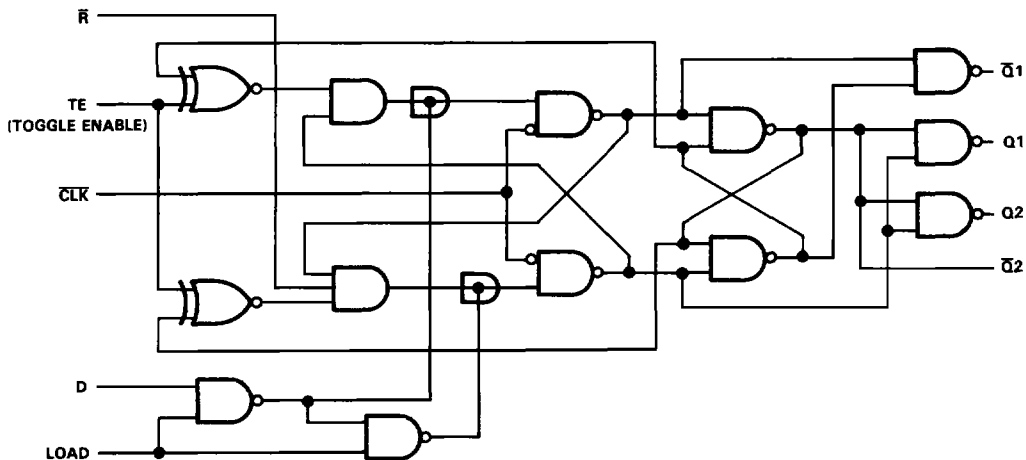
logic symbol, each flip-flop (positive logic)



logic diagram, each flip-flop in 'F160A (positive logic)



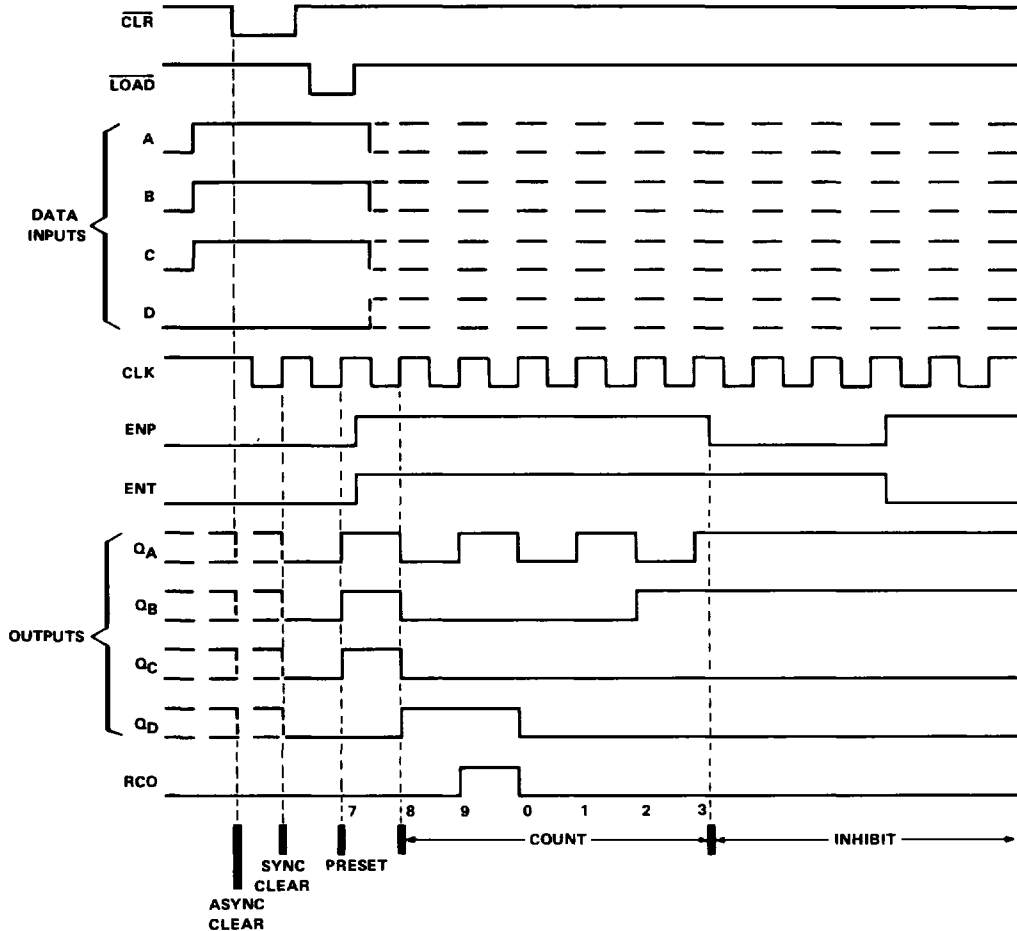
logic diagram, each flip-flop in 'F162A (positive logic)



typical clear, preset, count, and inhibit sequences

Illustrated below is the following sequence:

1. Clear outputs to zero ('F160A is asynchronous; 'F162A is synchronous)
2. Preset to BCD seven
3. Count to eight, nine, zero, one, two, and three
4. Inhibit



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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)**

Supply voltage, $V_{CC}$ .....	-0.5 V to 7 V
Input voltage <sup>†</sup> .....	-1.2 V to 7 V
Input current .....	-30 mA to 5 mA
Voltage applied to any output in the high state .....	-0.5 V to $V_{CC}$
Current into any output in the low state .....	40 mA
Operating free-air temperature range: SN54F160A, SN54F162A .....	-65°C to 150°C
SN74F160A, SN74F162A .....	0°C to 70°C
Storage temperature range .....	-65°C to 150°C

<sup>†</sup>The input voltage ratings may be exceeded provided the input current ratings are observed.

**recommended operating conditions**

	SN54F160A SN54F162A			SN74F160A SN74F162A			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$ Supply voltage	4.5	5	5.5	4.5	5	5.5	V
$V_{IH}$ High-level input voltage	2			2			V
$V_{IL}$ Low-level input voltage			0.8			0.8	V
$I_{IK}$ Input clamp current			-18			-18	mA
$I_{OH}$ High-level outut current			-1			-1	mA
$I_{OL}$ Low-level output current			20			20	mA
$T_A$ Operating free-air temperature	-55		125	0		70	°C

**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	SN54F160A SN54F162A			SN74F160A SN74F162A			UNIT
		MIN	TYP <sup>‡</sup>	MAX	MIN	TYP <sup>‡</sup>	MAX	
$V_{IK}$	$V_{CC} = 4.5 V, I_I = -18 mA$			-1.2			-1.2	V
$V_{OH}^{\S}$	$V_{CC} = 4.5 V, I_{OH} = -1 mA$	2.5	3.4		2.5	3.4		V
$V_{OL}$	$V_{CC} = 4.5 V, I_{OL} = 20 mA$			0.3			0.3	V
$I_I$	$V_{CC} = 5.5 V, V_I = 7 V$						0.1	mA
$I_{IH}$	$V_{CC} = 5.5 V, V_I = 2.7 V$						20	$\mu A$
$I_{IL}$	$V_{CC} = 5.5 V, V_I = 0.5 V$	ENP, CLK, A, B, C, D					-0.6	mA
		ENT, $\overline{LOAD}$					-1.2	
		$\overline{CLR}$ ('F160A)					-0.6	
		$\overline{CLR}$ ('F162A)					-1.2	
$I_{OS}^{\ddagger}$	$V_{CC} = 5.5 V, V_O = 0$	-60		-150	-60		-150	mA
$I_{CC}$	$V_{CC} = 5.5 V$		37	55		37	55	mA

<sup>‡</sup>All typical values are at  $V_{CC} = 5 V, T_A = 25^\circ C$ .

<sup>\S</sup>For SN74F160A and SN74F162A at  $V_{CC} = 4.75 V$  and  $I_{OH} = -1 mA, V_{OH} min = 2.7 V$ .

<sup>\ddagger</sup>Not more than one output should be shorted at a time and the duration of the short circuit should not exceed one second.

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**timing requirements**

		$V_{CC} = 5 V,$ $T_A = 25^{\circ}C$		$V_{CC} = 4.5 V \text{ to } 5.5 V,$ $T_A = \text{MIN to MAX}^{\dagger}$				UNIT
		'F160A, 'F162A		SN54F160A SN54F162A		SN74F160A SN74F162A		
		MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency	0	100			0	90	MHz
$t_{\text{su}}$	Setup time, data (A, B, C, D) high or low before CLK $\uparrow$	5				5		ns
$t_{\text{hold}}$	Hold time, data (A, B, C, D) high or low after CLK $\uparrow$	2				2		ns
$t_{\text{su}}$	Setup time, $\overline{\text{LOAD}}$ and (for 'F162A) $\overline{\text{CLR}}$ before CLK $\uparrow$	High	11			11.5		ns
		Low	8.5			9.5		
$t_{\text{hold}}$	Hold time, $\overline{\text{LOAD}}$ and (for 'F162A) $\overline{\text{CLR}}$ after CLK $\uparrow$	High	2			2		ns
		Low	0			0		
$t_{\text{su}}$	Setup time, ENP and ENT before CLK $\uparrow$	High	11			11.5		ns
		Low	5			5		
$t_{\text{hold}}$	Hold time, ENP and ENT high or low after CLK $\uparrow$	0				0		ns
$t_w$	Pulse duration, CLK high or low (loading)	5				5		ns
$t_w$	Pulse duration, CLK (counting)	High	4			4		ns
		Low	6			7		
$t_w$	Pulse duration, $\overline{\text{CLR}}$ low ('F160A)	5				5		ns
$t_{\text{su}}$	Inactive-state setup time, $\overline{\text{CLR}}$ high before CLK $\uparrow$ ('F160A) $\ddagger$	6				6		ns

**switching characteristics (see Note 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 5 V,$ $C_L = 50 \text{ pF},$ $R_L = 500 \Omega,$ $T_A = 25^{\circ}C$			$V_{CC} = 4.5 V \text{ to } 5.5 V,$ $C_L = 50 \text{ pF},$ $R_L = 500 \Omega,$ $T_A = \text{MIN to MAX}^{\dagger}$				UNIT
			'F160A, 'F162A			SN54F160A SN54F162A		SN74F160A SN74F162A		
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
$f_{\text{max}}$			100	120			90		MHz	
$t_{\text{PLH}}$	CLK ( $\overline{\text{LOAD}}$ high)	Any Q	2.7	5.1	7.5			2.7	8.5	ns
$t_{\text{PHL}}$			2.7	7.1	10			2.7	11	
$t_{\text{PLH}}$	CLK ( $\overline{\text{LOAD}}$ low)	Any Q	3.2	5.6	8.5			3.2	9.5	ns
$t_{\text{PHL}}$			3.2	5.6	8.5			3.2	9.5	
$t_{\text{PLH}}$	CLK	RCO	4.2	9.6	14			4.2	15	ns
$t_{\text{PHL}}$			4.2	9.6	14			4.2	15	
$t_{\text{PLH}}$	ENT	RCO	1.7	4.1	7.5			1.7	8.5	ns
$t_{\text{PHL}}$			1.7	4.1	7.5			1.7	8.5	
$t_{\text{PHL}}$	$\overline{\text{CLR}}$ ('F160A)	Any Q	4.7	8.6	12			4.7	13	ns
$t_{\text{PHL}}$	$\overline{\text{CLR}}$ ('F160A)	RCO	3.7	7.6	10.5			3.7	11.5	ns

$\dagger$  For conditions shown as MIN or MAX, use the appropriate value specified under Recommended Operating Conditions.

$\ddagger$  Inactive-state setup time is also referred to as "recovery time".

NOTE 1: See General Information for load circuits and waveforms.

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