

DATA SHEET

For a complete data sheet, please also download:

- The IC06 74HC/HCT/HCU/HCMOS Logic Family Specifications
- The IC06 74HC/HCT/HCU/HCMOS Logic Package Information
- The IC06 74HC/HCT/HCU/HCMOS Logic Package Outlines

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74HC/HCT194

4-bit bidirectional universal shift register

Product specification
File under Integrated Circuits, IC06

December 1990

4-bit bidirectional universal shift register

74HC/HCT194

FEATURES

- Shift-left and shift-right capability
- Synchronous parallel and serial data transfer
- Easily expanded for both serial and parallel operation
- Asynchronous master reset
- Hold ("do nothing") mode
- Output capability: standard
- I_{CC} category: MSI

GENERAL DESCRIPTION

The 74HC/HCT194 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The functional characteristics of the 74HC/HCT194 4-bit bidirectional universal shift registers are indicated in the logic diagram and function table. The registers are fully synchronous.

The "194" design has special features which increase the range of application. The synchronous operation of the device is determined by the mode select inputs (S_0 , S_1). As shown in the mode select table, data can be entered

and shifted from left to right ($Q_0 \rightarrow Q_1 \rightarrow Q_2$, etc.) or, right to left ($Q_3 \rightarrow Q_2 \rightarrow Q_1$, etc.) or parallel data can be entered, loading all 4 bits of the register simultaneously. When both S_0 and S_1 are LOW, existing data is retained in a hold ("do nothing") mode. The first and last stages provide D-type serial data inputs (D_{SR} , D_{SL}) to allow multistage shift right or shift left data transfers without interfering with parallel load operation.

Mode select and data inputs are edge-triggered, responding only to the LOW-to-HIGH transition of the clock (CP). Therefore, the only timing restriction is that the mode control and selected data inputs must be stable one set-up time prior to the positive transition of the clock pulse.

The four parallel data inputs (D_0 to D_3) are D-type inputs. Data appearing on the D_0 to D_3 inputs, when S_0 and S_1 are HIGH, is transferred to the Q_0 to Q_3 outputs respectively, following the next LOW-to-HIGH transition of the clock. When LOW, the asynchronous master reset (MR) overrides all other input conditions and forces the Q outputs LOW.

The "194" is similar in operation to the "195" universal shift register, with added features of shift-left without external connections and hold ("do nothing") modes of operation.

QUICK REFERENCE DATA

GND = 0 V; $T_{amb} = 25^\circ\text{C}$; $t_r = t_f = 6\text{ ns}$

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PHL}/t_{PLH}	propagation delay CP to Q_n	$C_L = 15\text{ pF}$; $V_{CC} = 5\text{ V}$	14	15	ns
t_{PHL}	$\overline{\text{MR}}$ to Q_n		11	15	ns
f_{max}	maximum clock frequency		102	77	MHz
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per package	notes 1 and 2	40	40	pF

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz

f_o = output frequency in MHz

$\sum = (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs

C_L = output load capacitance in pF

V_{CC} = supply voltage in V

2. For HC the condition is $V_i = \text{GND to } V_{CC}$; for HCT the condition is $V_i = \text{GND to } V_{CC} - 1.5\text{ V}$

4-bit bidirectional universal shift register

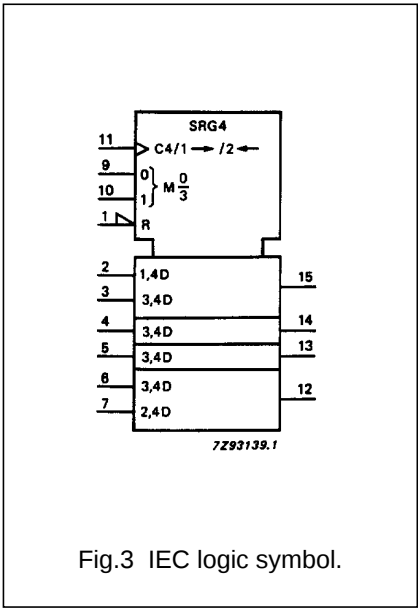
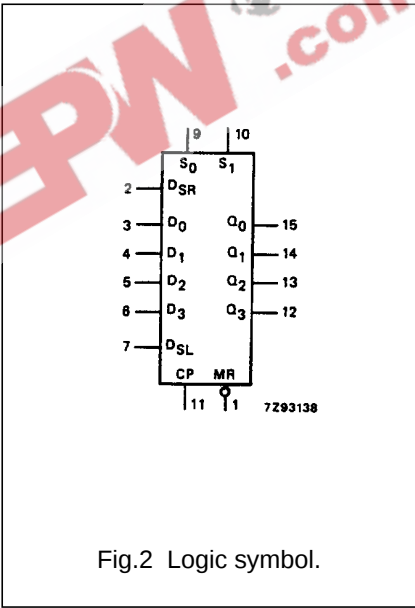
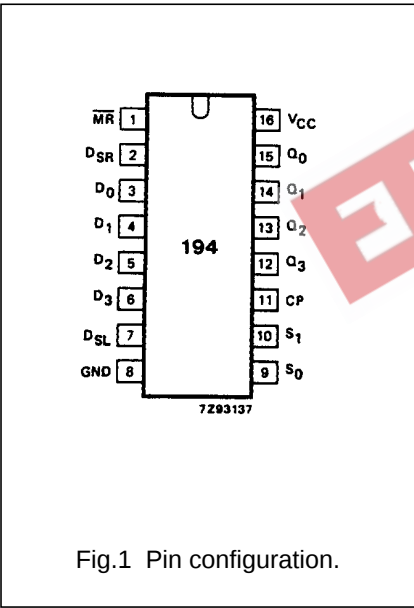
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ORDERING INFORMATION

See “74HC/HCT/HCU/HCMOS Logic Package Information”.

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
1	$\overline{\text{MR}}$	asynchronous master reset input (active LOW)
2	D_{SR}	serial data input (shift right)
3, 4, 5, 6	D_0 to D_3	parallel data inputs
7	D_{SL}	serial data input (shift left)
8	GND	ground (0 V)
9, 10	S_0 , S_1	mode control inputs
11	CP	clock input (LOW-to-HIGH edge-triggered)
15, 14, 13, 12	Q_0 to Q_3	parallel outputs
16	V_{CC}	positive supply voltage



4-bit bidirectional universal shift register

74HC/HCT194

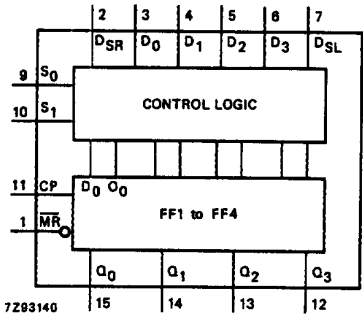


Fig.4 Functional diagram.

FUNCTION TABLE

OPERATING MODES	INPUTS							OUTPUTS			
	CP	MR	S ₁	S ₀	D _{SR}	D _{SL}	D _n	Q ₀	Q ₁	Q ₂	Q ₃
reset (clear)	X	L	X	X	X	X	X	L	L	L	L
hold ("do nothing")	X	H	l	l	X	X	X	q ₀	q ₁	q ₂	q ₃
shift left	↑	H	h	l	X	l	X	q ₁	q ₂	q ₃	L
	↑	H	h	l	X	h	X	q ₁	q ₂	q ₃	H
shift right	↑	H	l	h	l	X	X	L	q ₀	q ₁	q ₂
	↑	H	l	h	h	X	X	H	q ₀	q ₁	q ₂
parallel load	↑	H	h	h	X	X	d _n	d ₀	d ₁	d ₂	d ₃

Notes

- H = HIGH voltage level
h = HIGH voltage level one set-up time prior to the LOW-to-HIGH CP transition
L = LOW voltage level
l = LOW voltage level one set-up time prior to the LOW-to-HIGH CP transition
q,d = lower case letters indicate the state of the referenced input (or output) one set-up time prior to the LOW-to-HIGH CP transition
X = don't care
↑ = LOW-to-HIGH CP transition

4-bit bidirectional universal shift register

74HC/HCT194

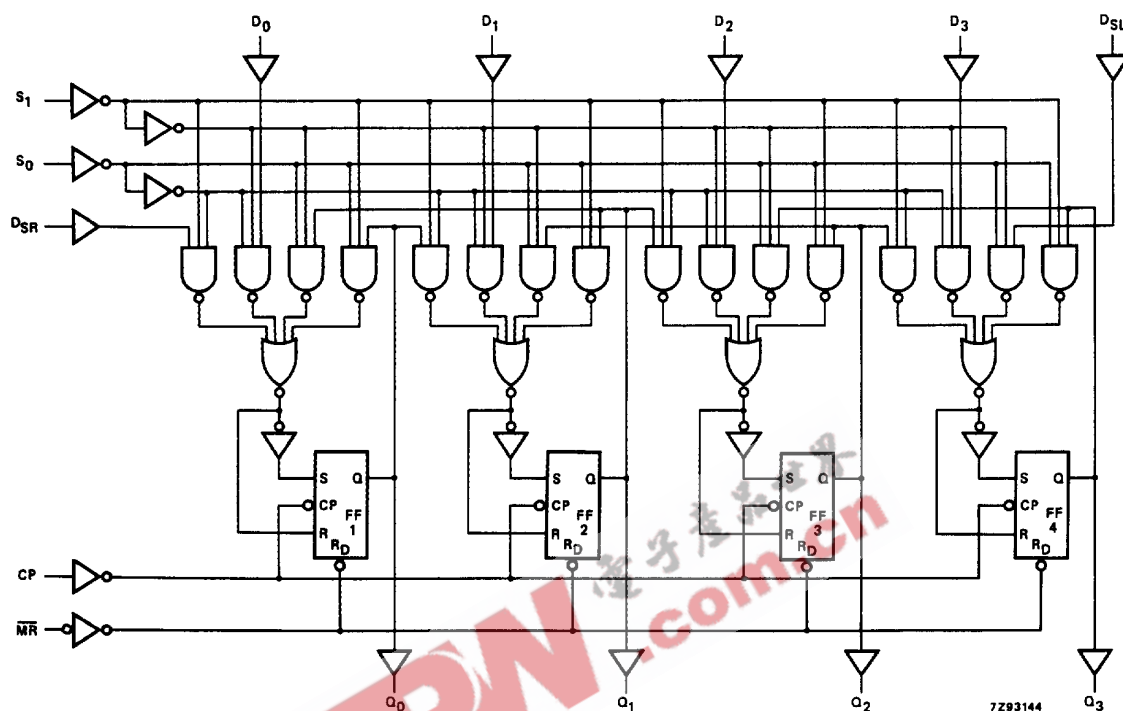


Fig.5 Logic diagram.

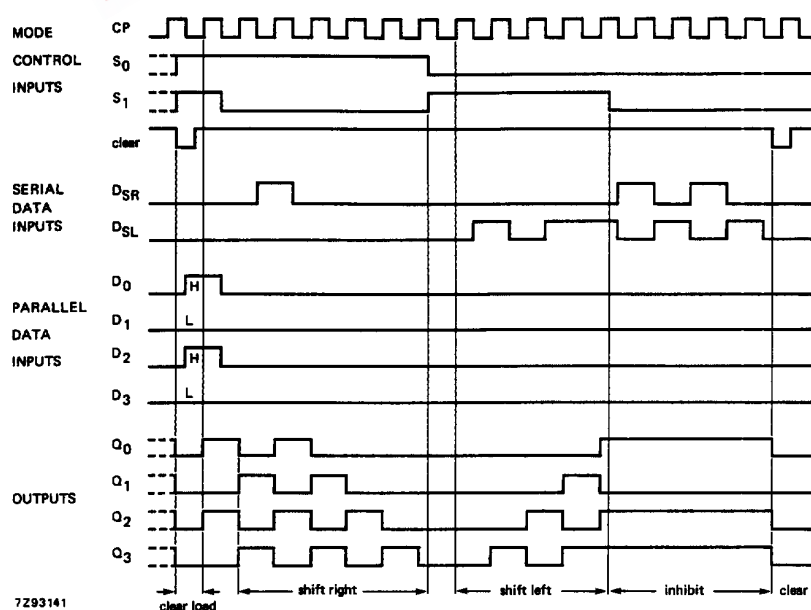


Fig.6 Typical clear, clear-load, shift-right, shift-left, inhibit and clear timing sequences.

4-bit bidirectional universal shift register

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DC CHARACTERISTICS FOR 74HC

For the DC characteristics see *"74HC/HCT/HCU/HCMOS Logic Family Specifications"*.

Output capability: standard

I_{CC} category: MSI

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4-bit bidirectional universal shift register

74HC/HCT194

AC CHARACTERISTICS FOR 74HC

GND = 0 V; $t_r = t_f = 6$ ns; $C_L = 50$ pF

SYMBOL	PARAMETER	T _{amb} (°C)							UNIT	TEST CONDITIONS	
		74HC								V _{CC} (V)	WAVEFORMS
		+25			−40 to +85		−40 to +125				
		min.	typ.	max.	min.	max.	min.	max.			
t _{PHL} / t _{PLH}	propagation delay CP to Q _n		47 17 14	145 29 25		180 36 31		220 44 38	ns	2.0 4.5 6.0	Fig.7
t _{PHL}	propagation delay MR to Q _n		39 14 11	140 28 24		175 35 30		210 42 36	ns	2.0 4.5 6.0	Fig.8
t _{THL} / t _{TLH}	output transition time		19 7 6	75 15 13		95 19 16		110 22 19	ns	2.0 4.5 6.0	Fig.7
t _w	clock pulse width HIGH or LOW	80 16 14	17 6 5		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.7
t _w	master reset pulse width; LOW	80 16 14	17 6 5		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.8
t _{rem}	removal time MR to CP	60 12 10	17 6 5		75 15 13		90 18 15		ns	2.0 4.5 6.0	Fig.8
t _{su}	set-up time D _n to CP	70 14 12	17 6 5		90 18 15		105 21 18		ns	2.0 4.5 6.0	Fig.9
t _{su}	set-up time S ₀ , S ₁ to CP	80 16 12	22 8 6		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.10
t _{su}	set-up time D _{SR} , D _{SL} to CP	70 14 12	19 7 6		90 18 15		105 21 18		ns	2.0 4.5 6.0	
t _h	hold time D _n to CP	0 0 0	−14 −5 −4		0 0 0		0 0 0		ns	2.0 4.5 6.0	Fig.9
t _h	hold time S ₀ , S ₁ to CP	0 0 0	−11 −4 −3		0 0 0		0 0 0		ns	2.0 4.5 6.0	Fig.10
t _h	hold time D _{SR} , D _{SL} to CP	0 0 0	−17 −6 −5		0 0 0		0 0 0		ns	2.0 4.5 6.0	
f _{max}	maximum clock pulse frequency	6.0 30 35	31 93 111		4.8 24 28		4.0 20 24		MHz	2.0 4.5 6.0	Fig.7

4-bit bidirectional universal shift register

74HC/HCT194

DC CHARACTERISTICS FOR 74HCT

For the DC characteristics see *"74HC/HCT/HCU/HCMOS Logic Family Specifications"*.

Output capability: standard

I_{CC} category: MSI

Note to HCT types

The value of additional quiescent supply current (ΔI_{CC}) for a unit load of 1 is given in the family specifications. To determine ΔI_{CC} per input, multiply this value by the unit load coefficient shown in the table below.

INPUT	UNIT LOAD COEFFICIENT
D _n	0.15
D _{SR} , D _{SL}	0.15
CP	0.50
$\overline{\text{MR}}$	0.45
S _n	0.90

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4-bit bidirectional universal shift register

74HC/HCT194

AC CHARACTERISTICS FOR 74HCT

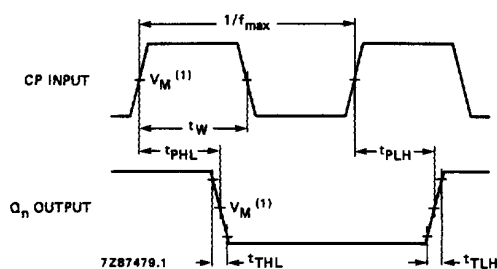
GND = 0 V; $t_r = t_f = 6$ ns; $C_L = 50$ pF

SYMBOL	PARAMETER	T _{amb} (°C)							UNIT	TEST CONDITIONS	
		74HCT								V _{CC} (V)	WAVEFORMS
		+25			−40 to +85		−40 to +125				
		min.	typ.	max.	min.	max.	min.	max.			
t _{PHL} / t _{PLH}	propagation delay CP to Q _n		18	32		40		48	ns	4.5	Fig.7
t _{PHL}	propagation delay MR to Q _n		18	32		40		48	ns	4.5	Fig.8
t _{THL} / t _{TLH}	output transition time		7	15		19		22	ns	4.5	Fig.7
t _W	clock pulse width HIGH or LOW	16	7		20		24		ns	4.5	Fig.7
t _W	master reset pulse width; LOW	16	7		20		24		ns	4.5	Fig.8
t _{rem}	removal time MR to CP	12	6		15		18		ns	4.5	Fig.8
t _{su}	set-up time D _n to CP	14	7		18		21		ns	4.5	Fig.9
t _{su}	set-up time S ₀ , S ₁ to CP	20	10		25		30		ns	4.5	Fig.10
t _{su}	set-up time D _{SR} , D _{SL} to CP	14			18		21		ns	4.5	Fig.9
t _h	hold time D _n to CP	0	−7		0		0		ns	4.5	Fig.9
t _h	hold time S ₀ , S ₁ to CP	0	−5		0		0		ns	4.5	Fig.10
t _h	hold time D _{SR} , D _{SL} to CP	0	−7		0		0		ns	4.5	Fig.9
f _{max}	maximum clock pulse frequency	30	70		24		20		MHz	4.5	Fig.7

4-bit bidirectional universal shift register

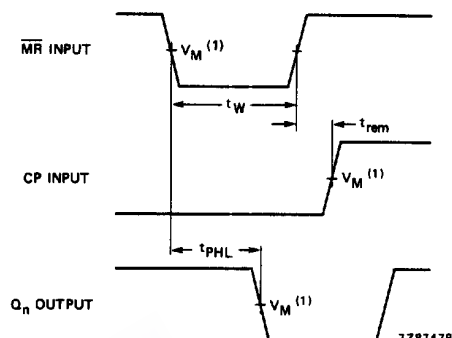
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AC WAVEFORMS



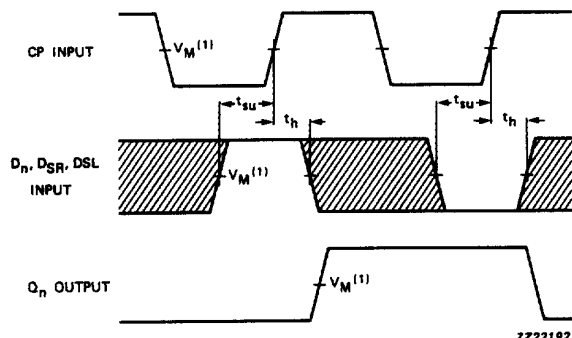
- (1) HC : $V_M = 50\%$; $V_I = \text{GND to } V_{CC}$.
HCT: $V_M = 1.3 \text{ V}$; $V_I = \text{GND to } 3 \text{ V}$.

Fig.7 Waveforms showing the clock (CP) to output (Q_n) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.



- (1) HC : $V_M = 50\%$; $V_I = \text{GND to } V_{CC}$.
HCT: $V_M = 1.3 \text{ V}$; $V_I = \text{GND to } 3 \text{ V}$.

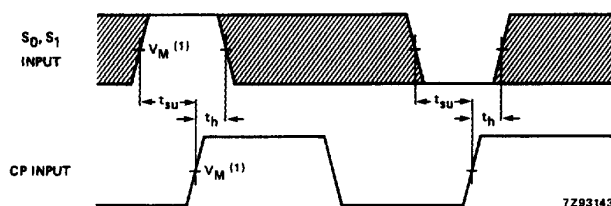
Fig.8 Waveforms showing the master reset ($\overline{\text{MR}}$) pulse width, the master reset to output (Q_n) propagation delays and the master reset to clock (CP) removal time.



The shaded areas indicate when the input is permitted to change for predictable output performance.

- (1) HC : $V_M = 50\%$; $V_I = \text{GND to } V_{CC}$.
HCT: $V_M = 1.3 \text{ V}$; $V_I = \text{GND to } 3 \text{ V}$.

Fig.9 Waveforms showing the set-up and hold times from the data inputs (D_n , D_{SR} and D_{SL}) to the clock (CP).



The shaded areas indicate when the input is permitted to change for predictable output performance.

- (1) HC : $V_M = 50\%$; $V_I = \text{GND to } V_{CC}$.
HCT: $V_M = 1.3 \text{ V}$; $V_I = \text{GND to } 3 \text{ V}$.

Fig.10 Waveforms showing the set-up and hold times from the mode control inputs (S_n) to the clock input (CP).

PACKAGE OUTLINES

See "74HC/HCT/HCU/HCMOS Logic Package Outlines".