4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTER

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

(continued on next page)

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PHL}/t_{PLH}	propagation delay CP to Q_n	C_L = 15 pF; V_{CC} = 5 V	14	15	ns
t_{PHL}	$\overline{MR}$ 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

GND = 0 V; T_{amb} = 25 °C; $t_r = t_f$ = 6 ns

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
   $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o)$ where:
   f_i = input frequency in MHz; C_L = output load capacitance in pF
   f_o = output frequency in MHz; V_{CC} = supply voltage in V
   $\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs
2. For HC the condition is V_I = GND to V_{CC}
   For HCT the condition is V_I = GND to $V_{CC} - 1.5$ V

PACKAGE OUTLINES

16-lead DIL; plastic (SOT38Z).

16-lead mini-pack; plastic (SO16; SOT109A).

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
1	$\overline{MR}$	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

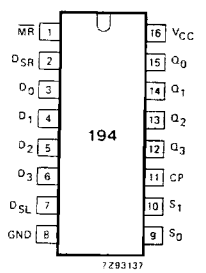

Fig. 1 Pin configuration.

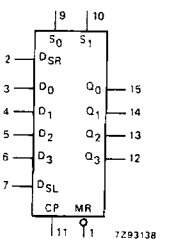

Fig. 2 Logic symbol.

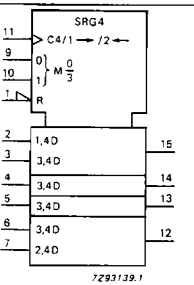

Fig. 3 IEC logic symbol.

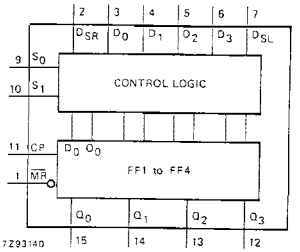

Fig. 4 Functional diagram.

FUNCTION TABLE

OPERATING MODES	INPUTS							OUTPUTS			
	CP	$\overline{MR}$	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	h h	l l	X X	l h	X X	q_1 q_1	q_2 q_2	q_3 q_3	L H
shift right	↑ ↑	H H	l l	h h	l h	X X	X X	L H	q_0 q_0	q_1 q_1	q_2 q_2
parallel load	↑	H	h	h	X	X	d_n	d_0	d_1	d_2	d_3

GENERAL DESCRIPTION (Cont'd.)

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 ($\overline{MR}$) 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.

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

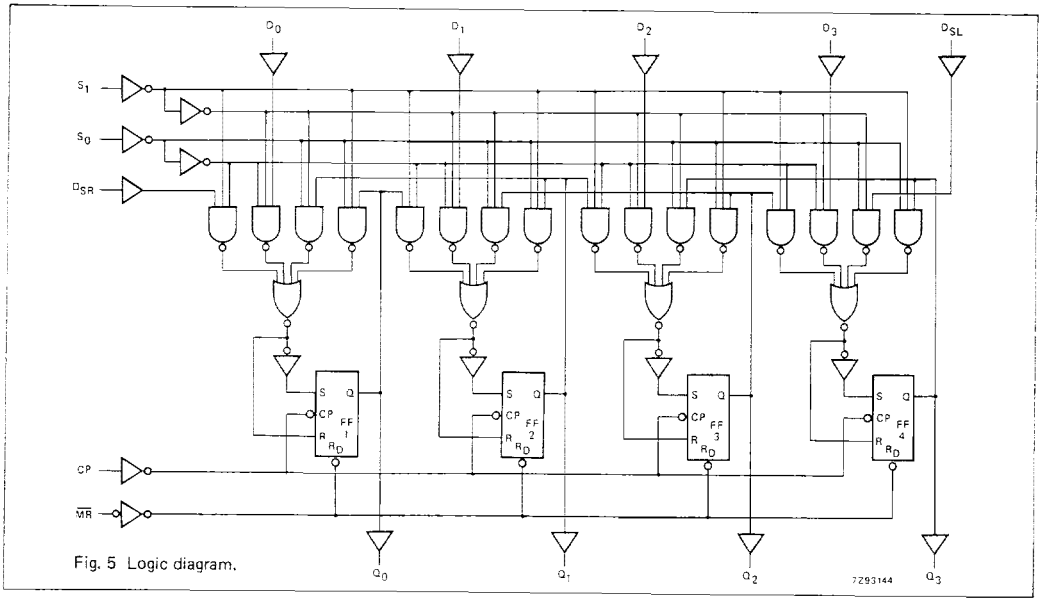

Fig. 5 Logic diagram.

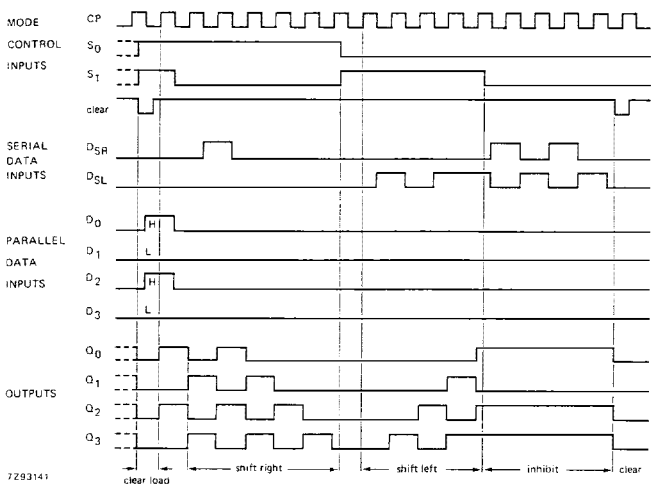

Fig. 6 Typical clear, clear-load, shift-right, shift-left, inhibit and clear timing sequences.

DC CHARACTERISTICS FOR 74HC

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: standard
I_{CC} category: MSI

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 $\overline{MR}$ 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 $\overline{MR}$ 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

DC CHARACTERISTICS FOR 74HCT

For the DC characteristics see chapter "HCMOS family characteristics", section "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
$\overline{CP}$	0.50
$\overline{MR}$	0.45
S_n	0.90

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 $\overline{MR}$ 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 $\overline{MR}$ 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

AC WAVEFORMS

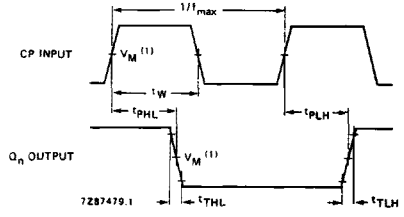

Fig. 7 Waveforms showing the clock (CP) to output (Q_n) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.

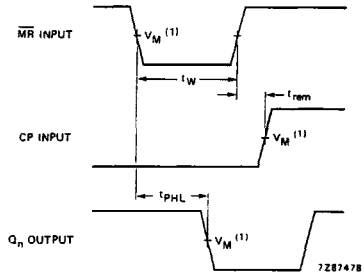

Fig. 8 Waveforms showing the master reset ($\overline{MR}$) pulse width, the master reset to output (Q_n) propagation delays and the master reset to clock (CP) removal time.

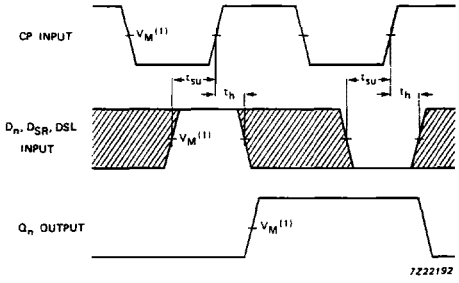

Fig. 9 Waveforms showing the set-up and hold times from the data inputs (D_n, D_{SR} and D_{SL}) to the clock (CP).

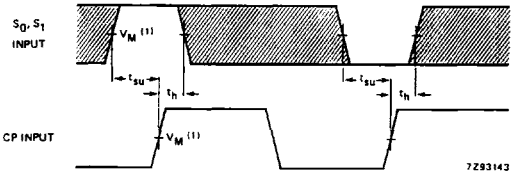

Fig. 10 Waveforms showing the set-up and hold times from the mode control inputs (S_n) to the clock input (CP).

Note to Figs 9 and 10

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

Note to AC waveforms

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