8-BIT PARALLEL-IN/SERIAL-OUT SHIFT REGISTER

FEATURES

- Synchronous parallel-to-serial applications
- Synchronous serial data input for easy expansion
- Clock enable for "do nothing" mode
- Asynchronous master reset
- For asynchronous parallel data load see "165"
- Output capability: standard
- I_{CC} category: MSI

GENERAL DESCRIPTION

The 74HC/HCT166 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 74HC/HCT166 are 8-bit shift registers which have a fully synchronous serial or parallel data entry selected by an active LOW parallel enable ($\overline{PE}$) input. When $\overline{PE}$ is LOW one set-up time prior to the LOW-to-HIGH clock transition, parallel data is entered into the register. When $\overline{PE}$ is HIGH, data is entered into the internal bit position Q_0 from serial data input (D_s), and the remaining bits are shifted one place to the right ($Q_0 \rightarrow Q_1 \rightarrow Q_2$, etc.) with each positive-going clock transition.

This feature allows parallel-to-serial converter expansion by tying the Q_7 output to the D_s input of the succeeding stage.

The clock input is a gated-OR structure which allows one input to be used as an active LOW clock enable ($\overline{CE}$) input. The pin assignment for the CP and $\overline{CE}$ inputs is arbitrary and can be reversed for layout convenience. The LOW-to-HIGH transition of input $\overline{CE}$ should only take place while CP is HIGH for predictable operation. A LOW on the master reset ($\overline{MR}$) input overrides all other inputs and clears the register asynchronously, forcing all bit positions to a LOW state.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PHL}/ t_{PLH}	propagation delay CP to Q_7 / $\overline{MR}$ to Q_7	C_L = 15 pF, V_{CC} = 5 V	15 / 14	20 / 19	ns / ns
f_{max}	maximum clock frequency		63	50	MHz
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per package	notes 1 and 2	41	41	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
   f_o = output frequency in MHz
   $\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs
   C_L = output load capacitance in pF
   V_{CC} = supply voltage in V
2. For HC the condition is V_I = 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	D_s	serial data input
2, 3, 4, 5, 10, 11, 12, 14	D_0 to D_7	parallel data inputs
6	$\overline{CE}$	clock enable input (active LOW)
7	CP	clock input (LOW-to-HIGH edge-triggered)
8	GND	ground (0 V)
9	$\overline{MR}$	asynchronous master reset input (active LOW)
13	Q_7	serial output from the last stage
15	$\overline{PE}$	parallel enable input (active LOW)
16	V_{CC}	positive supply voltage

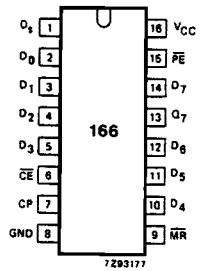

Fig. 1 Pin configuration.

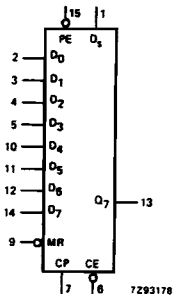

Fig. 2 Logic symbol.

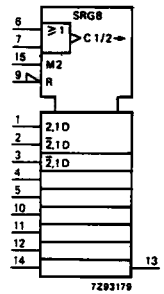

Fig. 3 IEC logic symbol.

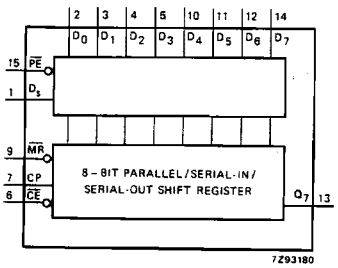

Fig. 4 Functional diagram.

FUNCTION TABLE

OPERATING MODES	INPUTS					Q_n REGISTER		OUTPUT
	$\overline{PE}$	$\overline{CE}$	CP	D_s	D_0-D_7	Q_0	Q_1-Q_6	Q_7
parallel load	l	l	↑	X	l - l	L	L - L	L
	l	l	↑	X	h - h	H	H - H	H
serial shift	h	l	↑	l	X - X	L	q_0 - q_5	q_6
	h	l	↑	h	X - X	H	q_0 - q_5	q_6
hold "do nothing"	X	h	X	X	X - X	q_0	q_1 - q_6	q_7

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 = lower case letters indicate the state of the referenced output one set-up time prior to the LOW-to-HIGH CP transition
X = don't care
↑ = LOW-to-HIGH CP transition

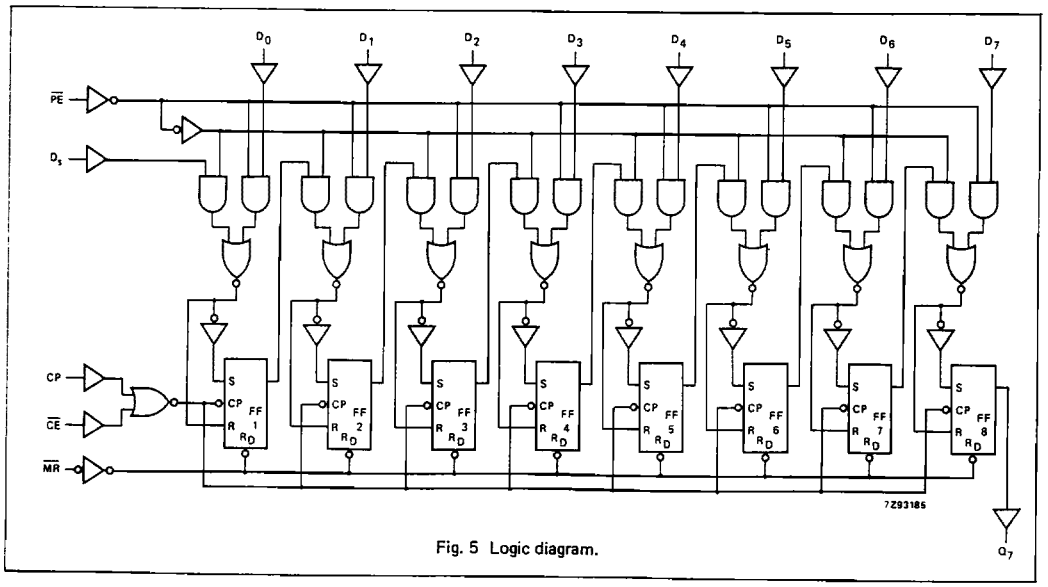

Fig. 5 Logic diagram.

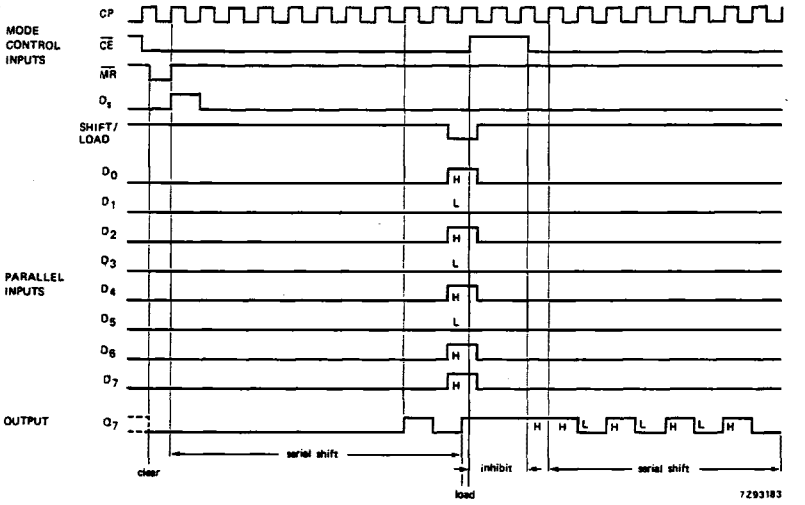

Fig. 6 Typical clear, shift, load, inhibit, and shift sequences.

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) 74HC +25 min.	+25 typ.	+25 max.	−40 to +85 min.	−40 to +85 max.	−40 to +125 min.	−40 to +125 max.	UNIT	TEST CONDITIONS V_{CC} V	TEST CONDITIONS WAVEFORMS
t_{PHL}/ t_{PLH}	propagation delay CP to Q_7		50 18 14	150 30 26		190 38 33		225 45 38	ns	2.0 4.5 6.0	Fig. 7
t_{PHL}	propagation delay $\overline{MR}$ to Q_7		47 17 14	160 32 27		200 40 34		240 48 41	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	100 20 17	25 9 7		125 25 21		150 30 26		ns	2.0 4.5 6.0	Fig. 8
t_{rem}	removal time $\overline{MR}$ to CP	0 0 0	−19 −7 −6		0 0 0		0 0 0		ns	2.0 4.5 6.0	Fig. 8
t_{su}	set-up time D_n, $\overline{CE}$ to CP	80 16 14	14 5 4		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig. 9
t_{su}	set-up time $\overline{PE}$ to CP	100 20 17	33 12 10		125 25 21		150 30 26		ns	2.0 4.5 6.0	Fig. 8
t_h	hold time D_n, $\overline{CE}$ to CP	2 2 2	−8 −3 −2		2 2 2		2 2 2		ns	2.0 4.5 6.0	Fig. 8
t_h	hold time $\overline{PE}$ to CP	0 0 0	−28 −10 −8		0 0 0		0 0 0		ns	2.0 4.5 6.0	Fig. 9
f_{max}	maximum clock pulse frequency	6.0 30 35	19 57 68		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_0 to D_7	0.35
D_s	0.35
CP	0.80
$\overline{CE}$	0.80
$\overline{MR}$	0.40
$\overline{PE}$	0.60

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_7		23	40		50		60	ns	4.5	Fig. 7
t_{PHL}	propagation delay $\overline{MR}$ to Q_7		22	40		50		60	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	20	9		25		30		ns	4.5	Fig. 7
t_W	master reset pulse width LOW	25	11		31		38		ns	4.5	Fig. 8
t_{rem}	removal time $\overline{MR}$ to CP	0	−7		0		0		ns	4.5	Fig. 8
t_{su}	set-up time D_n, $\overline{CE}$ to CP	16	8		20		24		ns	4.5	Fig. 9
t_{su}	set-up time $\overline{PE}$ to CP	30	15		38		45		ns	4.5	Fig. 8
t_h	hold time D_n, $\overline{CE}$ to CP	0	−3		0		0		ns	4.5	Fig. 9
t_h	hold time $\overline{PE}$ to CP	0	−13		0		0		ns	4.5	Fig. 9
f_{max}	maximum clock pulse width	25	45		20		17		MHz	4.5	Fig. 7

AC WAVEFORMS

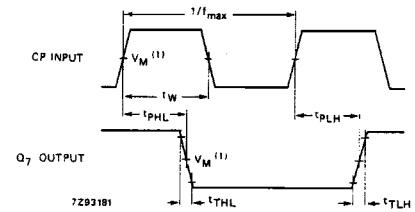

Fig. 7 Waveforms showing the clock (CP) to output (Q_7) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.

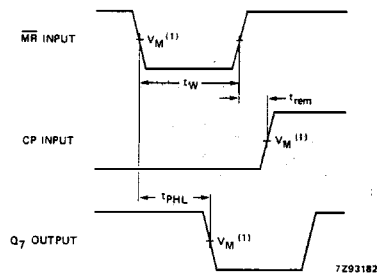

Fig. 8 Waveforms showing the master reset ($\overline{MR}$) pulse width, the master reset to output (Q_7) propagation delay and the master reset to clock (CP) removal time.

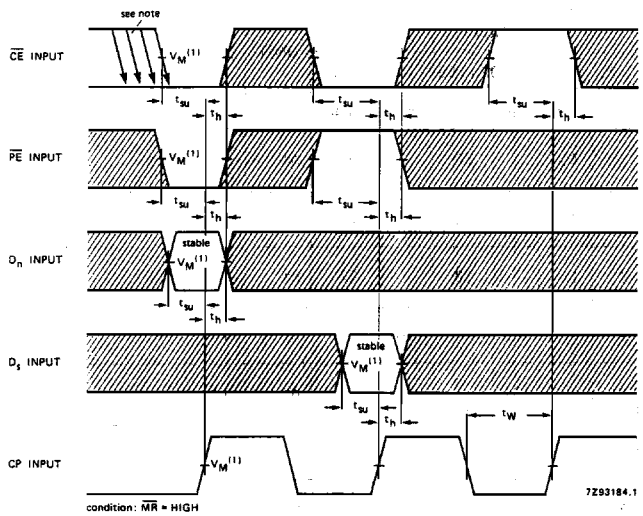

Fig. 9 Waveforms showing the set-up and hold times from the serial data input (D_S), the data inputs (D_n), the clock enable input (LOW $\overline{CE}$), the clock enable input $\overline{CE}$ and the parallel enable input to the clock (CP).

Note to Fig. 7

The changing to output assumes internal Q_6 opposite state from Q_7.

Note to Figs 7, 8 and 9

The number of clock pulses required between the t_{PLH} and t_{PHL} measurements can be determined from the function table.

Note to Fig. 9

$\overline{CE}$ may change only from HIGH-to-LOW while CP is LOW.

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.