

8-bit parallel-in/serial-out shift register

74HC/HCT165

FEATURES

- Asynchronous 8-bit parallel load
- Synchronous serial input
- Output capability: standard
- I_{CC} category: MSI

GENERAL DESCRIPTION

The 74HC/HCT165 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/HCT165 are 8-bit parallel-load or serial-in shift registers with complementary serial outputs (Q_7 and $\overline{Q}_7$) available from the last stage. When the parallel load (PL) input is LOW, parallel data from the D_0 to D_7 inputs are loaded into the register asynchronously.

When $\overline{PL}$ is HIGH, data enters the register serially at the D_S input and shifts 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 HIGH for predictable operation. Either the CP or the $\overline{CE}$ should be HIGH before the LOW-to-HIGH transition of PL to prevent shifting the data when $\overline{PL}$ is activated.

APPLICATIONS

- Parallel-to-serial data conversion

QUICK REFERENCE DATA

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

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t _{PHL} / t _{PLH}	propagation delay CP to Q_7 , $\overline{Q}_7$ PL to Q_7 , $\overline{Q}_7$ D_7 to Q_7 , $\overline{Q}_7$	C _L = 15 pF; V _{CC} = 5 V	16	14	ns
			15	17	ns
			11	11	ns
			56	48	MHz
f _{max}	maximum clock frequency				
C _I	input capacitance		3.5	3.5	pF
C _{PD}	power dissipation capacitance per package	notes 1 and 2	35	35	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 = GND to V_{CC}
For HCT the condition is V_I = GND to V_{CC} – 1.5 V

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
1	$\overline{PL}$	asynchronous parallel load input (active LOW)
7	$\overline{Q_7}$	complementary output from the last stage
9	Q_7	serial output from the last stage
2	CP	clock input (LOW-to-HIGH edge-triggered)
8	GND	ground (0 V)
10	D_s	serial data input
11, 12, 13, 14, 3, 4, 5, 6	D_0 to D_7	parallel data inputs
15	$\overline{CE}$	clock enable input (active LOW)
16	V_{CC}	positive supply voltage

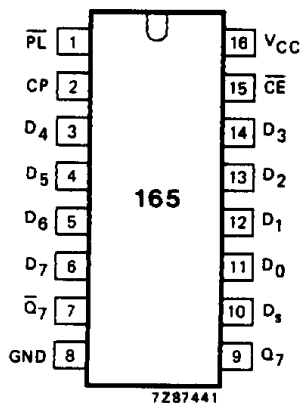


Fig.1 Pin configuration.

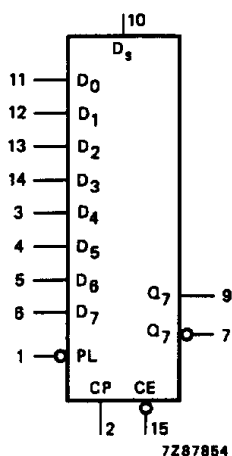


Fig.2 Logic symbol.

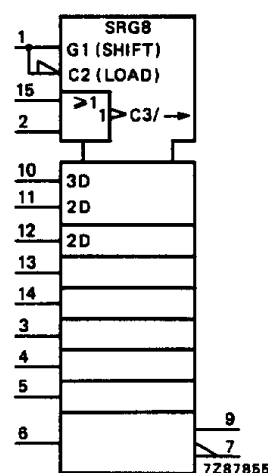


Fig.3 IEC logic symbol.

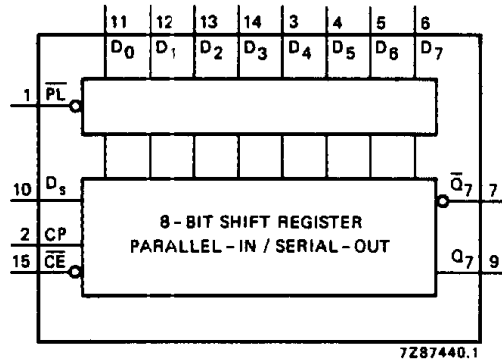


Fig.4 Functional diagram.

FUNCTION TABLE

OPERATING MODES	INPUTS					Q _n REGISTERS		OUTPUTS	
	$\overline{PL}$	$\overline{CE}$	CP	D _S	D ₀ -D ₇	Q ₀	Q ₁ -Q ₆	Q ₇	$\overline{Q_7}$
parallel load	L	X	X	X	L	L	L - L	L	H
	L	X	X	X	H	H	H - H	H	L
serial shift	H	L	↑	L	X	L	q ₀ -q ₅	q ₆	$\overline{q_6}$
	H	L	↑	h	X	H	q ₀ -q ₅	q ₆	q ₆
hold "do nothing"	H	H	X	X	X	q ₀	q ₁ -q ₆	q ₇	q ₇

Note

1. H = HIGH voltage level
h = HIGH voltage level one set-up time prior to the LOW-to-HIGH clock transition
L = LOW voltage level
l = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition
q = lower case letters indicate the state of the referenced output one set-up time prior to the LOW-to-HIGH clock transition
X = don't care
↑ = LOW-to-HIGH clock transition

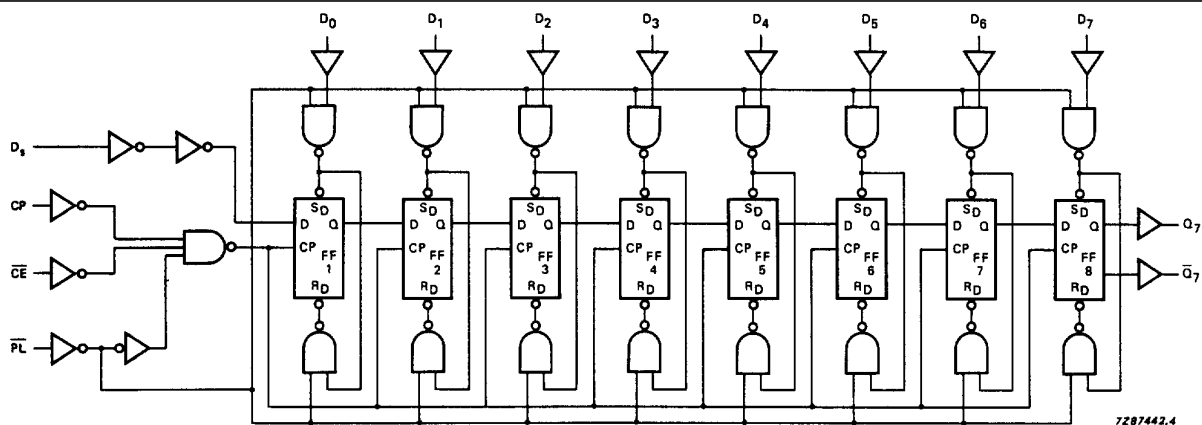


Fig.5 Logic diagram.

DC CHARACTERISTICS FOR 74HC

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

Output capability: standard

I_{CC} category: MSI

AC CHARACTERISTICS FOR HC

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 CE, CP to Q ₇ , $\overline{Q}_7$		52 19 15	165 33 28		205 41 35		250 50 43	ns	2.0 4.5 6.0	Fig.6
t _{PHL} / t _{PLH}	propagation delay PL to Q ₇ , $\overline{Q}_7$		50 18 14	165 33 28		205 41 35		250 50 43	ns	2.0 4.5 6.0	Fig.6
t _{PHL} / t _{PLH}	propagation delay D ₇ to Q ₇ , $\overline{Q}_7$		36 13 10	120 24 20		150 30 26		180 36 31	ns	2.0 4.5 6.0	Fig.6
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.6
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.6
t _w	parallel load pulse width; LOW	80 16 14	14 5 4		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.6
t _{rem}	removal time PL to CP, CE	100 20 17	22 8 6		125 25 21		150 30 26		ns	2.0 4.5 6.0	Fig.6
t _{su}	set-up time D _s to CP, $\overline{CE}$	80 16 14	11 4 3		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.6
t _{su}	set-up time CE to CP; CP to $\overline{CE}$	80 16 14	17 6 5		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.6
t _{su}	set-up time D _n to $\overline{PL}$	80 16 14	22 8 6		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig.6

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 _h	hold time D _s to CP, $\overline{\text{CE}}$ D _n to $\overline{\text{PL}}$	5	6		5		5		ns	2.0	Fig.6
		5	2		5		5			4.5	
		5	2		5		5			6.0	
t _h	hold time $\overline{\text{CE}}$ to CP CP to $\overline{\text{CE}}$	5	−17		5		5		ns	2.0	Fig.6
		5	−6		5		5			4.5	
		5	−5		5		5			6.0	
f _{max}	maximum clock pulse frequency	6	17		5		4		MHz	2.0	Fig.6
		30	51		24		20			4.5	
		35	61		28		24			6.0	



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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	0.35
D _s	0.35
CP	0.65
$\overline{CE}$	0.65
PL	0.65

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 CE, CP to Q ₇ , $\overline{Q}_7$		17	34		43		51	ns	4.5	Fig.6
t _{PHL} / t _{PLH}	propagation delay $\overline{PL}$ to Q ₇ , $\overline{Q}_7$		20	40		50		60	ns	4.5	Fig.6
t _{PHL} / t _{PLH}	propagation delay D ₇ to Q ₇ , $\overline{Q}_7$		14	28		35		42	ns	4.5	Fig.6
t _{THL} / t _{TLH}	output transition time		7	15		19		22	ns	4.5	Fig.6
t _W	clock pulse width HIGH or LOW	16	6		20		24		ns	4.5	Fig.6
t _W	parallel load pulse width; LOW	20	9		25		30		ns	4.5	Fig.6
t _{rem}	removal time PL to CP, $\overline{CE}$	20	8		25		30		ns	4.5	Fig.6
t _{su}	set-up time D _s to CP, $\overline{CE}$	20	2		25		30		ns	4.5	Fig.6
t _{su}	set-up time $\overline{CE}$ to CP; CP to $\overline{CE}$	20	7		25		30		ns	4.5	Fig.6
t _{su}	set-up time D _n to $\overline{PL}$	20	10		25		30		ns	4.5	Fig.6
t _h	hold time D _s to CP, $\overline{CE}$; D _n to $\overline{PL}$	7	−1		9		11		ns	4.5	Fig.6
t _h	hold time $\overline{CE}$ to CP, CP to $\overline{CE}$	0	−7		0		0		ns	4.5	Fig.6
f _{max}	maximum clock pulse frequency	26	44		21		17		MHz	4.5	Fig.6

AC WAVEFORMS

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

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

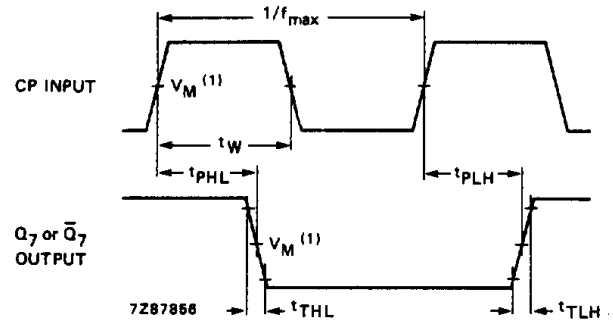


Fig.6 Waveforms showing the clock (CP) to output (Q_7 or $\bar{Q}_7$) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.

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

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

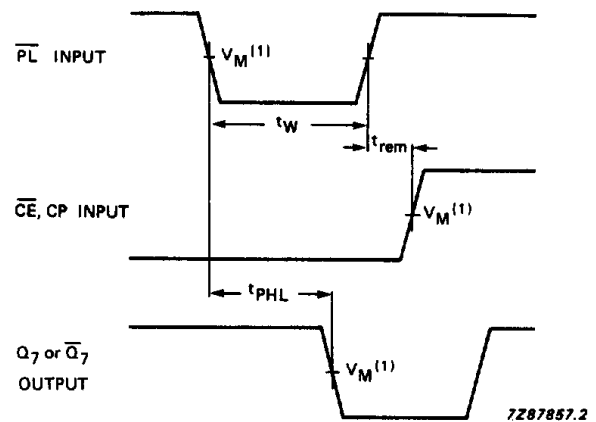


Fig.7 Waveforms showing the parallel load ($\overline{PL}$) pulse width, the parallel load to output (Q_7 or $\bar{Q}_7$) propagation delays, the parallel load to clock (CP) and clock enable ($\overline{CE}$) removal time.

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

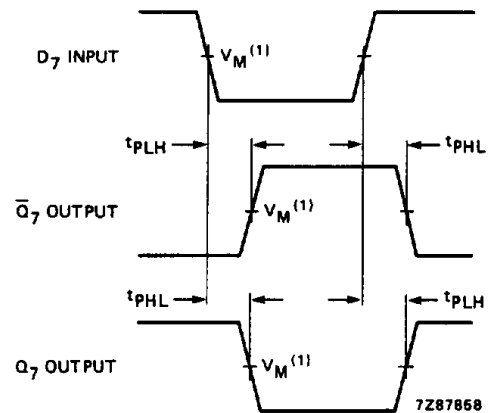


Fig.8 Waveforms showing the data input (D_n) to output (Q_7 or $\bar{Q}_7$) propagation delays when $\overline{PL}$ is LOW.

$\overline{CE}$ 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.

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

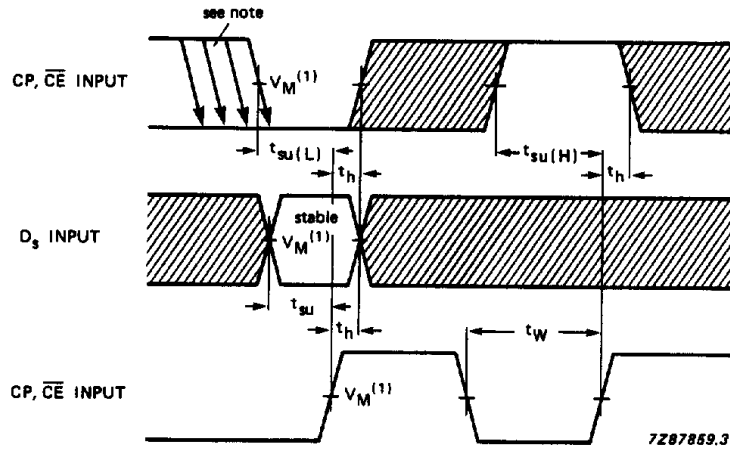


Fig.9 Waveforms showing the set-up and hold times from the serial data input (D_s) to the clock (CP) and clock enable ($\overline{CE}$) inputs, from the clock enable input ($\overline{CE}$) to the clock input (CP) and from the clock input (CP) to the clock enable input ($\overline{CE}$).

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

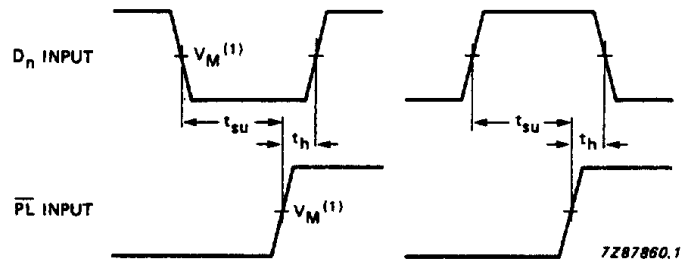


Fig.10 Waveforms showing the set-up and hold times from the data inputs (D_n) to the parallel load input ($\overline{PL}$).

PACKAGE OUTLINES

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