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

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 ($\overline{PL}$) 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 $\overline{PL}$ to prevent shifting the data when $\overline{PL}$ is activated.

APPLICATIONS

- **Parallel-to-serial data conversion**

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PHL}/t_{PLH}	propagation delay CP to Q_7, $\overline{Q_7}$ $\overline{PL}$ to Q_7, $\overline{Q_7}$ D_7 to Q_7, $\overline{Q_7}$	C_L = 15 pF V_{CC} = 5 V	16 15 11	14 17 11	ns ns ns
f_{max}	maximum clock frequency		56	48	MHz
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per package	notes 1 and 2	35	35	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	$\overline{PL}$	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

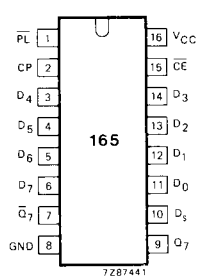

Fig. 1 Pin configuration.

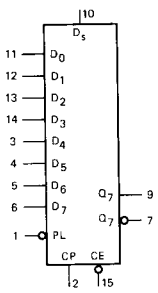

Fig. 2 Logic symbol.

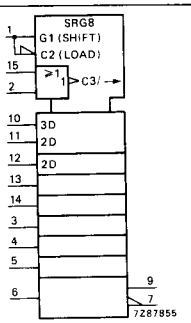

Fig. 3 IEC logic symbol.

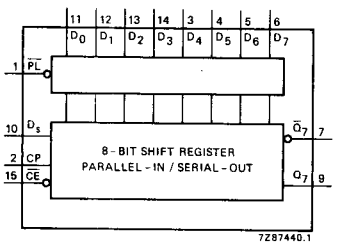

Fig. 4 Functional diagram.

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 L	X X	X X	X X	L H	L H	L - L H - H	L H	H L
serial shift	H H	L L	↑ ↑	l h	X X	L H	q_0-q_5 q_0-q_5	q_6 q_6	$\overline{q_6}$ $\overline{q_6}$
hold "do nothing"	H	H	X	X	X	q_0	q_1-q_6	q_7	q_7

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

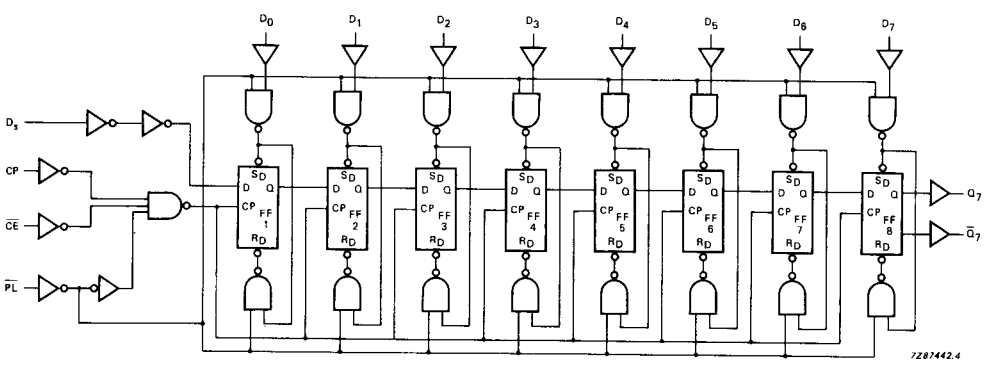

Fig. 5 Logic diagram.

DC CHARACTERISTICS FOR 74HC

For the DC characteristics see 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 $\overline{CE}$, 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 $\overline{PL}$ 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. 7
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. 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. 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. 7
t_{rem}	removal time $\overline{PL}$ to CP, $\overline{CE}$	100 20 17	22 8 6		125 25 21		150 30 26		ns	2.0 4.5 6.0	Fig. 7
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. 9
t_{su}	set-up time $\overline{CE}$ 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. 9
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. 10
t_h	hold time D_s to CP, $\overline{CE}$ D_n to $\overline{PL}$	5 5 5	6 2 2		5 5 5		5 5 5		ns	2.0 4.5 6.0	Fig. 9
t_h	hold time $\overline{CE}$ to CP CP to $\overline{CE}$	5 5 5	−17 −6 −5		5 5 5		5 5 5		ns	2.0 4.5 6.0	Fig. 9
f_{max}	maximum clock pulse frequency	6 30 35	17 51 61		5 24 28		4 20 24		MHz	2.0 4.5 6.0	Fig. 6

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	0.35
D_s	0.35
$\overline{CP}$	0.65
$\overline{CE}$	0.65
$\overline{PL}$	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 $\overline{CE}$, 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. 7
t_{PHL}/t_{PLH}	propagation delay D_7 to Q_7, $\overline{Q}_7$		14	28		35		42	ns	4.5	Fig. 8
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. 7
t_{rem}	removal time $\overline{PL}$ to CP, $\overline{CE}$	20	8		25		30		ns	4.5	Fig. 7
t_{su}	set-up time D_s to CP, $\overline{CE}$	20	2		25		30		ns	4.5	Fig. 9
t_{su}	set-up time $\overline{CE}$ to CP; CP to $\overline{CE}$	20	7		25		30		ns	4.5	Fig. 9
t_{su}	set-up time D_n to $\overline{PL}$	20	10		25		30		ns	4.5	Fig. 10
t_h	hold time D_s to CP, $\overline{CE}$; D_n to $\overline{PL}$	7	−1		9		11		ns	4.5	Fig. 9
t_h	hold time $\overline{CE}$ to CP, CP to $\overline{CE}$	0	−7		0		0		ns	4.5	Fig. 9
f_{max}	maximum clock pulse frequency	26	44		21		17		MHz	4.5	Fig. 6

AC WAVEFORMS

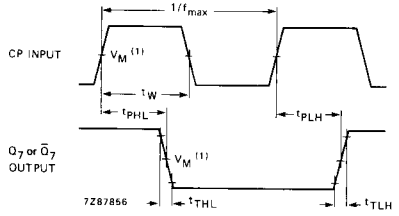

Fig. 6 Waveforms showing the clock (CP) to output (Q_7 or $\overline{Q}_7$) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.

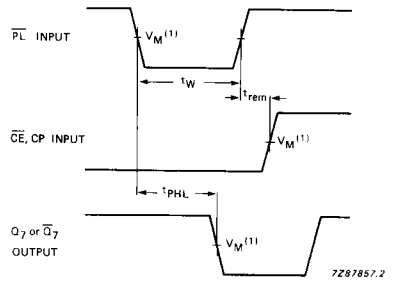

Fig. 7 Waveforms showing the parallel load ($\overline{PL}$) pulse width, the parallel load to output (Q_7 or $\overline{Q}_7$) propagation delays, the parallel load to clock (CP) and clock enable ($\overline{CE}$) removal time.

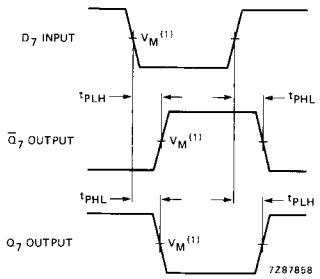

Fig. 8 Waveforms showing the data input (D_n) to output (Q_7 or $\overline{Q}_7$) propagation delays when $\overline{PL}$ is LOW.

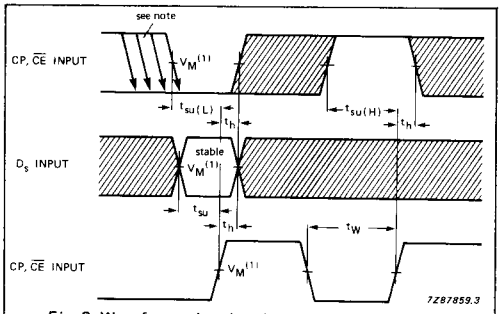

Fig. 9 Waveforms showing the set-up and hold times from the serial data input (D_s) to the clock (CP) and clock enable ($\overline{CE}$) inputs, from the clock enable input ($\overline{CE}$) to the clock input (CP) and from the clock input (CP) to the clock enable input ($\overline{CE}$).

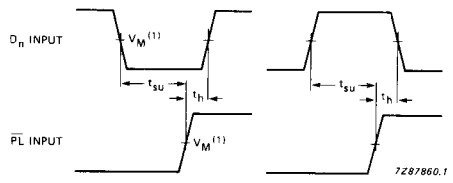

Fig. 10 Waveforms showing the set-up and hold times from the data inputs (D_n) to the parallel load input ($\overline{PL}$).

Note to Figs 6 and 7

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

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.