

CD74HC165, CD74HCT165

High Speed CMOS Logic 8-Bit Parallel-In/Serial-Out Shift Register

February 1998

Features

- Buffered Inputs
- Asynchronous Parallel Load
- Complementary Outputs
- Typical $f_{MAX} = 60\text{MHz}$ at $V_{CC} = 5\text{V}$, $C_L = 15\text{pF}$, $T_A = 25^\circ\text{C}$
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
 - 2V to 6V Operation
 - High Noise Immunity: $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC} at $V_{CC} = 5\text{V}$
- HCT Types
 - 4.5V to 5.5V Operation
 - Direct LSTTL Input Logic Compatibility, $V_{IL} = 0.8\text{V}$ (Max), $V_{IH} = 2\text{V}$ (Min)
 - CMOS Input Compatibility, $I_I \leq 1\mu\text{A}$ at V_{OL} , V_{OH}

Description

The Harris CD74HC165 and CD74HCT165 are 8-bit parallel 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 D0 to D7 inputs are loaded into the register asynchronously. When the \overline{PL} is HIGH, data enters the register serially at the DS 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 allow parallel-to-serial converter expansion by typing the Q_7 output to the DS input of the succeeding device.

For predictable operation the LOW-to-HIGH transition of \overline{CE} should only take place while CP is HIGH. Also, CP and \overline{CE} should be LOW before the LOW-to-HIGH transition of PL to prevent shifting the data when \overline{PL} goes HIGH.

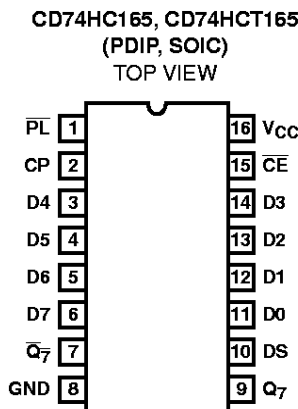
Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CD74HC165E	-55 to 125	16 Ld PDIP	E16.3
CD74HCT165E	-55 to 125	16 Ld PDIP	E16.3
CD74HC165M	-55 to 125	16 Ld SOIC	M16.15
CD74HCT165M	-55 to 125	16 Ld SOIC	M16.15

NOTES:

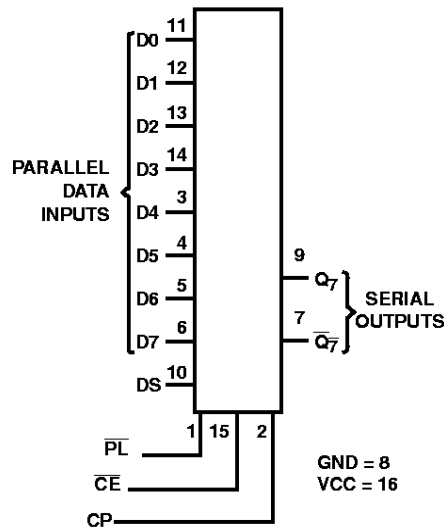
1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer and die is available which meets all electrical specifications. Please contact your local sales office or Harris customer service for ordering information.

Pinout



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Functional Diagram



TRUTH TABLE

OPERATING MODE	INPUTS					Q _n REGISTER		OUTPUTS	
	\overline{PL}	\overline{CE}	CP	DS	D0 - D7	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	$\overline{q_6}$
Hold Do Nothing	H	H	X	X	X	q ₀	q ₁ - q ₆	q ₇	$\overline{q_7}$

NOTE:

- H = High Voltage Level
- h = High Voltage Level One Set-up Time Prior To The Low-to-high Clock Transition
- l = Low Voltage Level One Set-up Time Prior To The Low-to-high Clock Transition
- L = Low Voltage Level
- X = Don't Care
- ↑ = Transition from Low to High Level
- q_n = Lower Case Letters Indicate The State Of the Reference Output Clock Transition

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Absolute Maximum Ratings

DC Supply Voltage, V_{CC}	-0.5V to 7V
DC Input Diode Current, I_{IK}	
For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$	$\pm 20mA$
DC Output Diode Current, I_{OK}	
For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$	$\pm 20mA$
DC Drain Current per Output, I_O	
For $V_O < -0.5V$ $V_O > V_{CC} + 0.5V$	$\pm 25mA$
DC Output Source or Sink Current per Output Pin, I_O	
For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$	$\pm 25mA$
DC V_{CC} or Ground Current, I_{CC} or I_{GND}	$\pm 50mA$

Thermal Information

Thermal Resistance (Typical, Note 3)	θ_{JA} ($^{\circ}C/W$)
PDIP Package	90
SOIC Package	115
Maximum Junction Temperature	150 $^{\circ}C$
Maximum Storage Temperature Range	-65 $^{\circ}C$ to 150 $^{\circ}C$
Maximum Lead Temperature (Soldering 10s)	300 $^{\circ}C$ (SOIC - Lead Tips Only)

Operating Conditions

Temperature Range (T_A)	-55 $^{\circ}C$ to 125 $^{\circ}C$
Supply Voltage Range, V_{CC}	
HC Types	2V to 6V
HCT Types	4.5V to 5.5V
DC Input or Output Voltage, V_I , V_O	0V to V_{CC}
Input Rise and Fall Time	
2V	1000ns (Max)
4.5V	500ns (Max)
6V	400ns (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25 $^{\circ}C$			-40 $^{\circ}C$ TO 85 $^{\circ}C$		-55 $^{\circ}C$ TO 125 $^{\circ}C$		UNITS	
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX		
HC TYPES													
High Level Input Voltage	V_{IH}	-	-	2	1.5	-	-	1.5	-	1.5	-	V	
				4.5	3.15	-	-	3.15	-	3.15	-	V	
				6	4.2	-	-	4.2	-	4.2	-	V	
Low Level Input Voltage	V_{IL}	-	-	2	-	-	0.5	-	0.5	-	0.5	V	
				4.5	-	-	1.35	-	1.35	-	1.35	V	
				6	-	-	1.8	-	1.8	-	1.8	V	
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads	V_{OH}	V_{IH} or V_{IL}	-4	-4	4.5	3.98	-	-	3.84	-	3.7	-	V
			-5.2	-5.2	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads	V_{OL}	V_{IH} or V_{IL}	4	4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	5.2	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	± 0.1	-	± 1	-	± 1	μA	

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DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	μA
HCT TYPES												
High Level Input Voltage	V_{IH}	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V_{IL}	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High Level Output Voltage TTL Loads			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads			4	4.5	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} to GND	0	5.5	-	-	± 0.1	-	± 1	-	± 1	μA
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	5.5	-	-	8	-	80	-	160	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load (Note 4)	ΔI_{CC} (Note 4)	V_{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA

NOTE:

4. For dual-supply systems theoretical worst case ($V_I = 2.4V$, $V_{CC} = 5.5V$) specification is 1.8mA.

HCT Input Loading Table

INPUT	UNIT LOADS
DS, D0 to D7	0.35
CP, \overline{PL}	0.65

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Specifications table, e.g. 360 μA max at 25°C.

Prerequisite For Switching Specifications

PARAMETER	SYMBOL	V_{CC} (V)	25°C		-40°C TO 85°C		-55°C TO 125°C		UNITS
			MIN	MAX	MIN	MAX	MIN	MAX	
HC TYPES									
CP Pulse Width	t_{WL}, t_{WH}	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns

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Prerequisite For Switching Specifications (Continued)

PARAMETER	SYMBOL	V _{CC} (V)	25°C		-40°C TO 85°C		-55°C TO 125°C		UNITS
			MIN	MAX	MIN	MAX	MIN	MAX	
PL Pulse Width	t _{WL}	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Set-up Time DS to CP	t _{SU}	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
CE to CP	t _{SU(L)}	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
D0-D7 to PL	t _{SU}	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Hold Time DS to CP or CE	t _H	2	35	-	45	-	55	-	ns
		4.5	7	-	9	-	11	-	ns
		6	6	-	8	-	9	-	ns
CE to CP	t _H	2	0	-	0	-	0	-	ns
		4.5	0	-	0	-	0	-	ns
		6	0	-	0	-	0	-	ns
Recovery Time PL to CP	t _{REC}	2	100	-	125	-	150	-	ns
		4.5	20	-	25	-	30	-	ns
		6	17	-	21	-	26	-	ns
Maximum Clock Pulse Frequency	f _{MAX}	2	6	-	5	-	4	-	MHz
		4.5	30	-	24	-	20	-	MHz
		6	35	-	28	-	24	-	MHz

HCT TYPES

CP Pulse Width	t _{WL} , t _{WH}	4.5	18	-	23	-	27	-	ns
PL Pulse Width	t _{WL}	4.5	20	-	25	-	30	-	ns
Set-up Time DS to CP	t _{SU}	4.5	20	-	25	-	30	-	ns
CE to CP	t _{SU(L)}	4.5	20	-	25	-	30	-	ns
D0-D7 to PL	t _{SU}	6	20	-	25	-	30	-	ns
Hold Time DS to CP or CE	t _H	4.5	7	-	9	-	11	-	ns
CE to CP	t _S , t _H	4.5	0	-	0	-	0	-	ns
Recovery Time PL to CP	t _{REC}	4.5	20	-	25	-	30	-	ns
Maximum Clock Pulse Frequency	f _{MAX}	4.5	27	-	22	-	18	-	MHz

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Switching Specifications Input $t_r, t_f = 6\text{ns}$

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C		-40°C TO 85°C	-55°C TO 125°C	UNITS
				TYP	MAX	MAX	MAX	
HC TYPES								
Propagation Delay CP or \overline{CE} to Q_7 or $\overline{Q_7}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	2	-	165	205	250	ns
			4.5	-	33	41	50	ns
		$C_L = 15\text{pF}$	5	13	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	28	35	43	ns
\overline{PL} to Q_7 or $\overline{Q_7}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	2	-	175	220	265	ns
			4.5	-	35	44	53	ns
		$C_L = 15\text{pF}$	5	14	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	30	37	45	ns
D7 to Q_7 or $\overline{Q_7}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	2	-	150	190	225	ns
			4.5	-	30	38	45	ns
		$C_L = 15\text{pF}$	5	12	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	26	33	38	ns
Output Transition Times	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	2	-	75	95	110	ns
			4.5	-	15	19	22	ns
			6	-	13	16	19	ns
Input Capacitance	C_{IN}	-	-	-	10	10	10	pF
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	17	-	-	-	pF
HCT TYPES								
Propagation Delay CP or \overline{CE} to Q_7 or $\overline{Q_7}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	40	50	60	ns
		$C_L = 15\text{pF}$	5	17	-	-	-	ns
\overline{PL} to Q_7 or $\overline{Q_7}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	40	50	60	ns
		$C_L = 15\text{pF}$	5	17	-	-	-	ns
D7 to Q_7 or $\overline{Q_7}$	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	35	44	53	ns
		$C_L = 15\text{pF}$	5	14	-	-	-	ns
Output Transition Times	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	15	19	22	ns
Input Capacitance	C_{IN}	$C_L = 50\text{pF}$	-	-	10	10	10	pF
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	24	-	-	-	pF

NOTES:

5. C_{PD} is used to determine the dynamic power consumption, per package.
6. $P_D = V_{CC}^2 f_i + \sum (C_L V_{CC}^2 + f_O)$ where f_i = Input Frequency, f_O = Output Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms

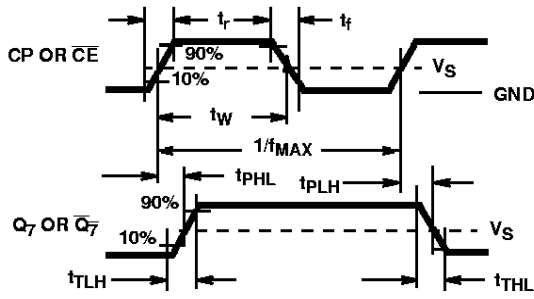


FIGURE 1. SERIAL-SHIFT MODE

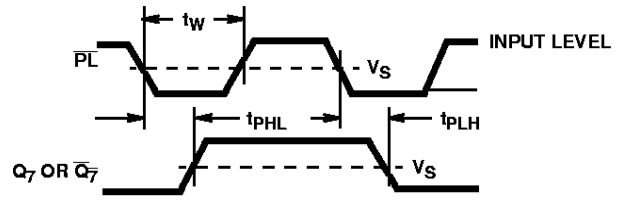


FIGURE 2. PARALLEL-LOAD MODE

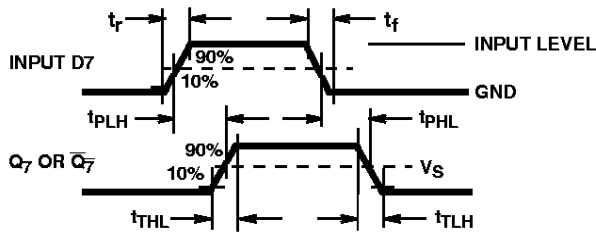


FIGURE 3. PARALLEL-LOAD MODE

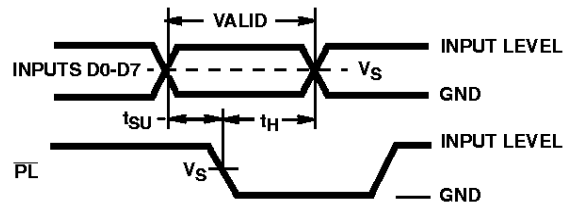


FIGURE 4. PARALLEL-LOAD MODE

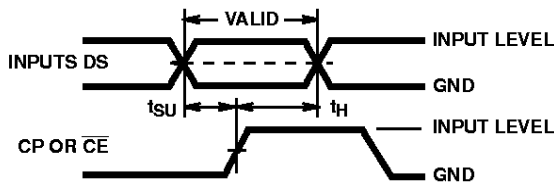


FIGURE 5. SERIAL-SHIFT MODE

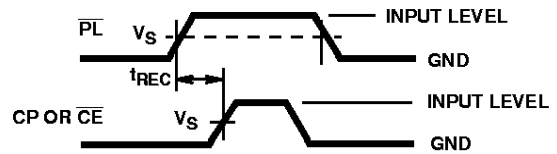


FIGURE 6. SERIAL-SHIFT MODE

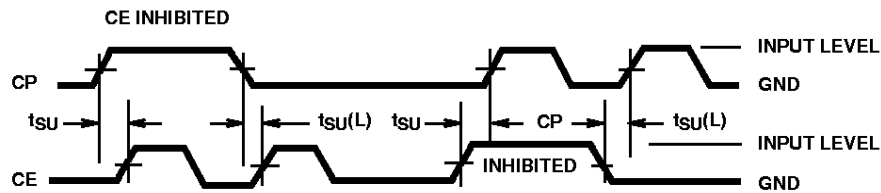


FIGURE 7. SERIAL-SHIFT, CLOCK-INHIBIT MODE