

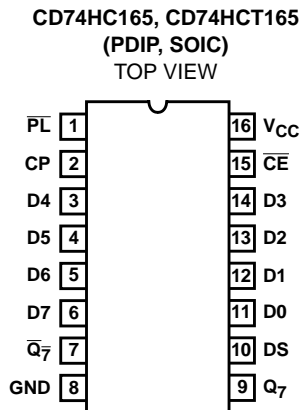
# CD74HC165, CD74HCT165

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

### 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 . . .  $-55^\circ\text{C}$  to  $125^\circ\text{C}$
- 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  $V_{OL}$ ,  $V_{OH}$

### Pinout



## CD74HC165, CD74HCT165

### Description

The Harris CD74HC165 and CD74HCT165 are 8-bit parallel or serial-in shift registers with complementary serial outputs ( $Q_7$  and  $\bar{Q}_7$ ) 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.

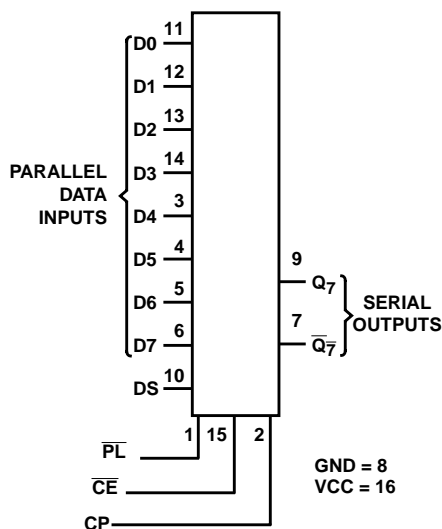
### Ordering Information

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:

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

### Functional Diagram



TRUTH TABLE

OPERATING MODE	INPUTS					Q <sub>n</sub> REGISTER		OUTPUTS	
	$\overline{PL}$	$\overline{CE}$	CP	DS	D0 - D7	Q <sub>0</sub>	Q <sub>1</sub> - Q <sub>6</sub>	Q <sub>7</sub>	$\bar{Q}_7$
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 <sub>0</sub> - q <sub>5</sub>	q <sub>6</sub>	$\bar{q}_6$
	H	L	↑	h	X	H	q <sub>0</sub> - q <sub>5</sub>	q <sub>6</sub>	$\bar{q}_6$
Hold Do Nothing	H	H	X	X	X	q <sub>0</sub>	q <sub>1</sub> - q <sub>6</sub>	q <sub>7</sub>	$\bar{q}_7$

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**TRUTH TABLE**

OPERATING MODE	INPUTS					Q <sub>n</sub> REGISTER		OUTPUTS	
	$\overline{PL}$	$\overline{CE}$	CP	DS	D0 - D7	Q <sub>0</sub>	Q <sub>1</sub> - Q <sub>6</sub>	Q <sub>7</sub>	$\overline{Q_7}$

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<sub>n</sub> = Lower Case Letters Indicate The State Of the Reference Output Clock Transition

# CD74HC165, CD74HCT165

## 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)	$\theta_{JA}$ (°C/W)
PDIP Package .....	90
SOIC Package .....	115
Maximum Junction Temperature .....	150°C
Maximum Storage Temperature Range .....	-65°C to 150°C
Maximum Lead Temperature (Soldering 10s) .....	300°C
(SOIC - Lead Tips Only)	

## Operating Conditions

Temperature Range ( $T_A$ ) .....	-55°C to 125°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:

- $\theta_{JA}$  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°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	
<b>HC TYPES</b>												
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	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads	$V_{OH}$	$V_{IH}$ or $V_{IL}$	-4	4.5	3.98	-	-	3.84	-	3.7	-	V
			-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	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads	$V_{OL}$	$V_{IH}$ or $V_{IL}$	4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	$I_I$	$V_{CC}$ or GND	-	6	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu A$

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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	$\mu$ A
<b>HCT TYPES</b>												
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	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu$ A
Quiescent Device Current	$I_{CC}$	$V_{CC}$ or GND	0	5.5	-	-	8	-	80	-	160	$\mu$ A
Additional Quiescent Device Current Per Input Pin: 1 Unit Load (Note 4)	$\Delta I_{CC}$ (Note 4)	$V_{CC}$ -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	$\mu$ A

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  $\Delta I_{CC}$  limit specified in DC Electrical Specifications table, e.g. 360 $\mu$ A 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	
<b>HC TYPES</b>									
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 <sub>CC</sub> (V)	25°C		-40°C TO 85°C		-55°C TO 125°C		UNITS
			MIN	MAX	MIN	MAX	MIN	MAX	
$\overline{\text{PL}}$ Pulse Width	$t_{\text{WL}}$	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Set-up Time DS to CP	$t_{\text{SU}}$	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
$\overline{\text{CE}}$ to CP	$t_{\text{SU(L)}}$	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
D0-D7 to $\overline{\text{PL}}$	$t_{\text{SU}}$	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Hold Time DS to CP or $\overline{\text{CE}}$	$t_{\text{H}}$	2	35	-	45	-	55	-	ns
		4.5	7	-	9	-	11	-	ns
		6	6	-	8	-	9	-	ns
$\overline{\text{CE}}$ to CP	$t_{\text{H}}$	2	0	-	0	-	0	-	ns
		4.5	0	-	0	-	0	-	ns
		6	0	-	0	-	0	-	ns
Recovery Time $\overline{\text{PL}}$ to CP	$t_{\text{REC}}$	2	100	-	125	-	150	-	ns
		4.5	20	-	25	-	30	-	ns
		6	17	-	21	-	26	-	ns
Maximum Clock Pulse Frequency	$f_{\text{MAX}}$	2	6	-	5	-	4	-	MHz
		4.5	30	-	24	-	20	-	MHz
		6	35	-	28	-	24	-	MHz

**HCT TYPES**

CP Pulse Width	$t_{\text{WL}}, t_{\text{WH}}$	4.5	18	-	23	-	27	-	ns
$\overline{\text{PL}}$ Pulse Width	$t_{\text{WL}}$	4.5	20	-	25	-	30	-	ns
Set-up Time DS to CP	$t_{\text{SU}}$	4.5	20	-	25	-	30	-	ns
$\overline{\text{CE}}$ to CP	$t_{\text{SU(L)}}$	4.5	20	-	25	-	30	-	ns
D0-D7 to $\overline{\text{PL}}$	$t_{\text{SU}}$	6	20	-	25	-	30	-	ns
Hold Time DS to CP or $\overline{\text{CE}}$	$t_{\text{H}}$	4.5	7	-	9	-	11	-	ns
$\overline{\text{CE}}$ to CP	$t_{\text{S}}, t_{\text{H}}$	4.5	0	-	0	-	0	-	ns
Recovery Time $\overline{\text{PL}}$ to CP	$t_{\text{REC}}$	4.5	20	-	25	-	30	-	ns
Maximum Clock Pulse Frequency	$f_{\text{MAX}}$	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	
<b>HC TYPES</b>								
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
$\overline{PL}$ 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
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
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
<b>HCT TYPES</b>								
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

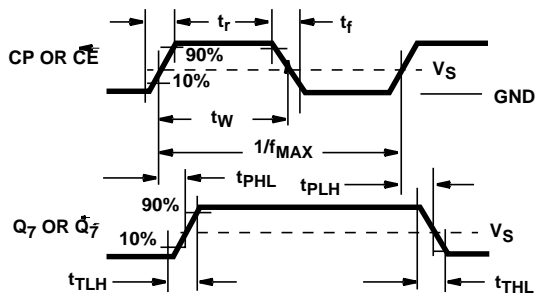


FIGURE 3. SERIAL-SHIFT MODE

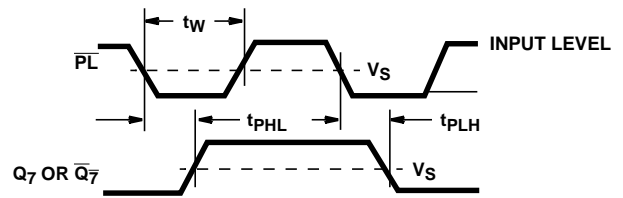


FIGURE 4. PARALLEL-LOAD MODE

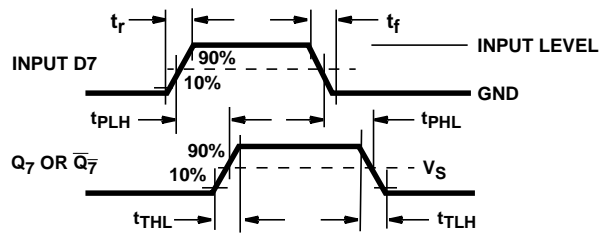


FIGURE 5. PARALLEL-LOAD MODE

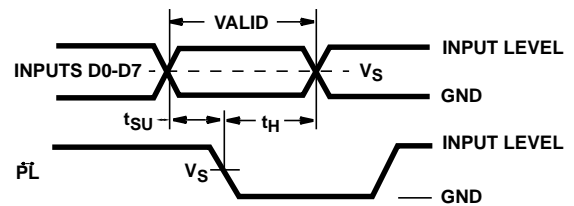


FIGURE 6. PARALLEL-LOAD MODE

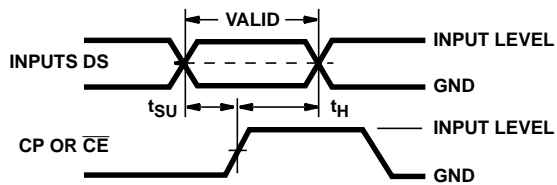


FIGURE 7. SERIAL-SHIFT MODE

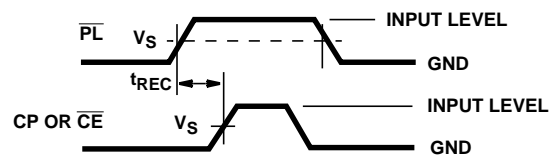


FIGURE 8. SERIAL-SHIFT MODE

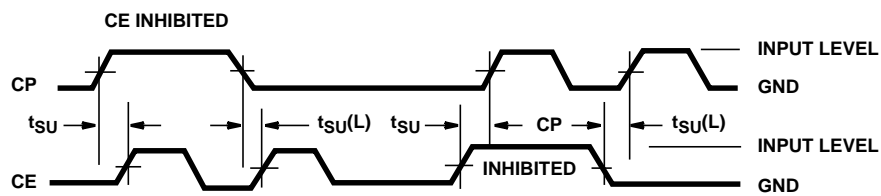


FIGURE 9. SERIAL-SHIFT, CLOCK-INHIBIT MODE



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