

October 1997 - Revised May 2000

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

Features

- Buffered Inputs
- Asynchronous Master Reset
- Typical $f_{MAX} = 50\text{MHz}$ 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 'HC164 and 'HCT164 are 8-bit serial-in parallel-out shift registers with asynchronous reset. Data is shifted on the positive edge of Clock (CP). A LOW on the Master Reset (MR) pin resets the shift register and all outputs go to the LOW state regardless of the input conditions. Two Serial Data inputs (DS1 and DS2) are provided, either one can be used as a Data Enable control.

Ordering Information

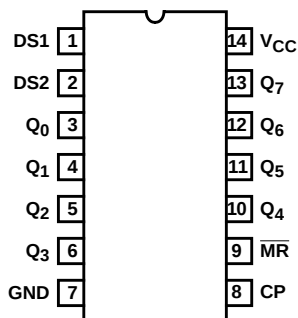
PART NUMBER	TEMP. RANGE ($^\circ\text{C}$)	PACKAGE
CD54HC164F	-55 to 125	14 Ld CERDIP
CD54HC164F3A	-55 to 125	14 Ld CERDIP
CD74HC164E	-55 to 125	14 Ld PDIP
CD74HC164M	-55 to 125	14 Ld SOIC
CD54HCT164F3A	-55 to 125	14 Ld CERDIP
CD74HCT164E	-55 to 125	14 Ld PDIP
CD74HCT164M	-55 to 125	14 Ld SOIC

NOTE:

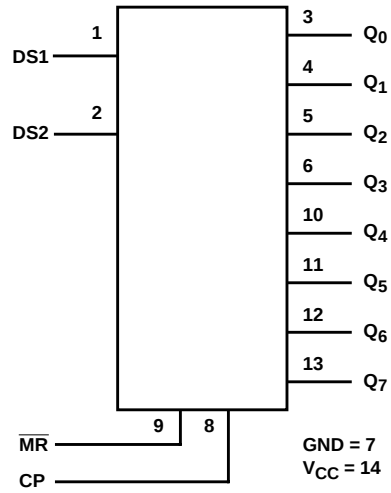
1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer and die is available which meets all electrical specifications. Please contact your local TI sales office or customer service for ordering information.

Pinout

CD54HC164, CD54HCT164
(CERDIP)
CD74HC164, CD74HCT164
(PDIP, SOIC)
TOP VIEW



Functional Diagram



TRUTH TABLE

OPERATING MODE	INPUTS				OUTPUTS	
	$\overline{\text{MR}}$	CP	DS1	DS2	Q ₀	Q ₁ - Q ₇
RESET (CLEAR)	L	X	X	X	L	L - L
Shift	H	↑	l	l	L	q ₀ - q ₆
	H	↑	l	h	L	q ₀ - q ₆
	H	↑	h	l	L	q ₀ - q ₆
	H	↑	h	h	H	q ₀ - q ₆

NOTES:

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 Input Clock Transition.

CD54/74HC164, CD54/74HCT164

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 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	175
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°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	
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	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
-4			4.5	3.98	-	-	3.84	-	3.7	-	V	
-5.2			6	5.48	-	-	5.34	-	5.2	-	V	
High Level Output Voltage TTL Loads												
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
			4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	6	-	-	0.26	-	0.33	-	0.4	V
Low Level Output Voltage TTL Loads												
Input Leakage Current	I _I	V _{CC} or GND	-	6	-	-	±0.1	-	±1	-	±1	µA
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	6	-	-	8	-	80	-	160	µA

CD54/74HC164, CD54/74HCT164

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	
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}	V _{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA

NOTE:

- 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
Date Shift-In (1, 2)	0.3
MR	0.9
Clock	0.7

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

Prerequisite For Switching Function

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									
Maximum Clock Frequency	f _{MAX}	2	6	-	5	-	4	-	MHz
		4.5	30	-	24	-	20	-	MHz
		6	35	-	28	-	24	-	MHz
MR Pulse Width	t _w	2	60	-	75	-	90	-	ns
		4.5	12	-	15	-	18	-	ns
		6	10	-	13	-	15	-	ns

CD54/74HC164, CD54/74HCT164

Prerequisite For Switching Function (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	
CP Pulse Width	t _W	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
Set-up Time	t _{SU}	2	60	-	75	-	90	-	ns
		4.5	12	-	15	-	18	-	ns
		6	10	-	13	-	15	-	ns
Hold Time	t _H	2	4	-	4	-	4	-	ns
		4.5	4	-	4	-	4	-	ns
		6	4	-	4	-	4	-	ns
$\overline{\text{MR}}$ to Clock, Removal Time	t _{REM}	2	80	-	100	-	120	-	ns
		4.5	16	-	20	-	24	-	ns
		6	14	-	17	-	20	-	ns
HCT TYPES									
Maximum Clock Frequency	f _{MAX}	4.5	27	-	22	-	18	-	MHz
MR Pulse Width	t _W	6	18	-	23	-	27	-	ns
CP Pulse Width	t _W	4.5	18	-	23	-	27	-	ns
Set-up Time	t _{SU}	6	12	-	15	-	18	-	ns
Hold Time	t _H	4.5	4	-	4	-	4	-	ns
MR to Clock, Removal Time	t _{REM}	6	16	-	20	-	24	-	ns

Switching Specifications Input t_r, t_f = 6ns

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 to Q _n	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	170	212	255	ns
			4.5	-	34	43	51	ns
		C _L = 15pF	5	14	-	-	-	ns
		C _L = 50pF	6	-	29	36	43	ns
$\overline{\text{MR}}$ to Q _n	t _{PLH} , t _{PHL}	C _L = 50pF	2	-	140	175	210	ns
			4.5	-	28	35	42	ns
		C _L = 15pF	5	11	-	-	-	ns
		C _L = 50pF	6	-	24	30	36	ns
Output Transition Times	t _{TLH} , t _{THL}	C _L = 50pF	2	-	75	-	110	ns
			4.5	-	15	-	22	ns
			6	-	13	-	19	ns
Maximum Clock Frequency	f _{MAX}	C _L = 15pF	5	60	-	-	-	MHz
Input Capacitance	C _{IN}	-	-	-	10	10	10	pF

CD54/74HC164, CD54/74HCT164

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

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C		-40°C TO 85°C	-55°C TO 125°C	UNITS
				TYP	MAX	MAX	MAX	
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	47	-	-	-	pF
HCT TYPES								
Propagation Delay, CP to Q_n	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	36	45	54	ns
		$C_L = 15\text{pF}$	5	15	-	-	-	ns
$\overline{MR}$ to Q_n	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	38	46	57	ns
		$C_L = 15\text{pF}$	5	16	-	-	-	ns
Output Transition Times	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	15	19	22	ns
Input Capacitance	C_{IN}	-	-	-	-	-	-	pF
Maximum Clock Frequency	f_{MAX}	$C_L = 15\text{pF}$	-	54	-	-	-	MHz
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	49	10	10	10	pF

NOTES:

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

Test Circuits and Waveforms

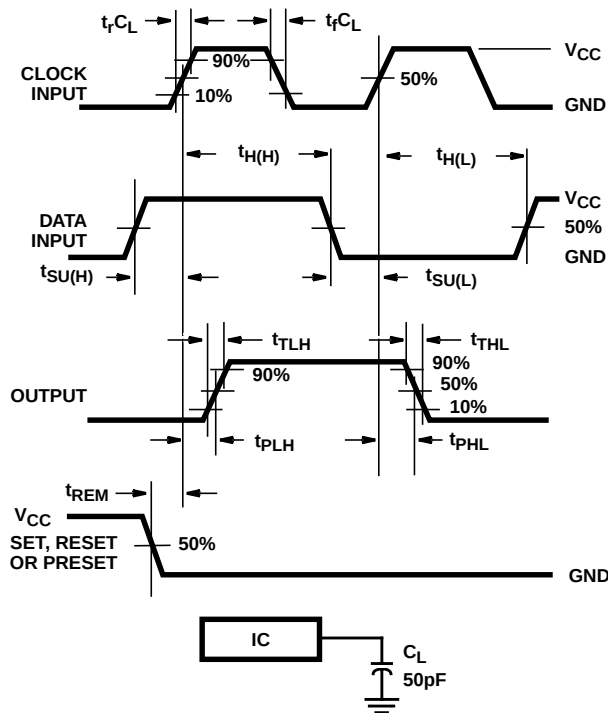


FIGURE 1. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

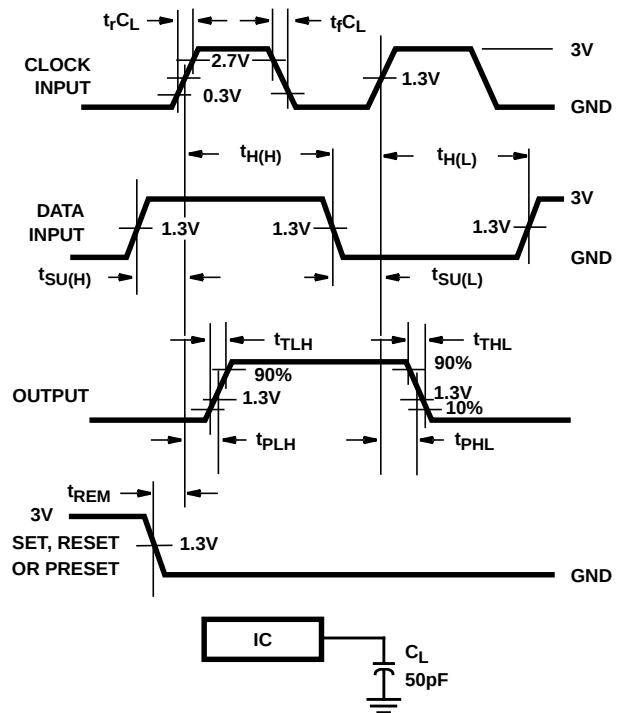


FIGURE 2. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

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