TEXAS INSTRUMENTS

Data sheet acquired from Harris Semiconductor
SCHS164

CD74HC194, CD74HCT194

High-Speed CMOS Logic
4-Bit Bidirectional Universal Shift Register

September 1997

Features

- **Four Operating Modes**
  - **Shift Right, Shift Left, Hold and Reset**
- **Synchronous Parallel or Serial Operation**
- **Typical f_{MAX} = 60MHz at V_{CC} = 5V, C_L = 15pF, $T_A = 25^oC$**
- **Asynchronous Master Reset**
- **Fanout (Over Temperature Range)**
  - **Standard Outputs . . . . . 10 LSTTL Loads**
  - **Bus Driver Outputs . . . . . 15 LSTTL Loads**
- **Wide Operating Temperature Range . . . -55^oC to 125^oC**
- **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} = 5V**
- **HCT Types**
  - **4.5V to 5.5V Operation**
  - **Direct LSTTL Input Logic Compatibility, V_{IL}= 0.8V (Max), V_{IH} = 2V (Min)**
  - **CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL}, V_{OH}**

Description

The Harris CD74HC194 and CD74HCT194 are 4-bit shift registers with Asynchronous Master Reset ($\overline{MR}$). In the parallel mode (S0 and S1 are high), data is loaded into the associated flip-flop and appears at the output after the positive transition of the clock input (CP). During parallel loading serial data flow is inhibited. Shift left and shift right are accomplished synchronously on the positive clock edge with serial data entered at the shift left (DSL) serial input for the shift right mode, and at the shift right (DSR) serial input for the shift left mode. Clearing the register is accomplished by a Low applied to the Master Reset ($\overline{MR}$) pin.

Ordering Information

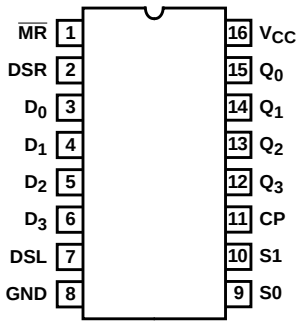
PART NUMBER	TEMP. RANGE (^oC)	PACKAGE	PKG. NO.
CD74HC194E	-55 to 125	16 Ld PDIP	E16.3
CD74HCT194E	-55 to 125	16 Ld PDIP	E16.3
CD74HC194M	-55 to 125	16 Ld SOIC	M16.15

NOTES:

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

Pinout

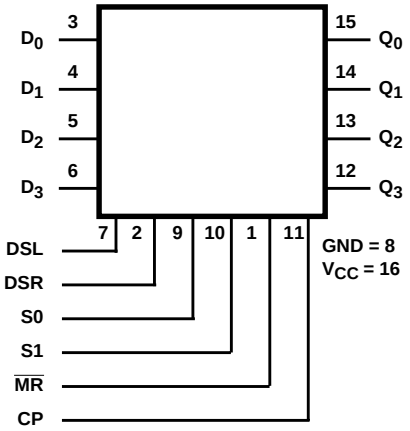
CD74HC194, CD74HCT194
(PDIP, SOIC)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

File Number **1668.1**

Functional Diagram



TRUTH TABLE

OPERATING MODE	INPUTS							OUTPUT			
	CP	$\overline{MR}$	S1	S0	DSR	DSL	D_n	Q_0	Q_1	Q_2	Q_3
Reset (Clear)	X	L	X	X	X	X	X	L	L	L	L
Hold (Do Nothing)	X	H	l (Note 2)	l (Note 2)	X	X	X	q_0	q_1	q_2	q_3
Shift Left	↑	H	h	l (Note 2)	X	l	X	q_1	q_2	q_3	L
	↑	H	h	l (Note 2)	X	h	X	q_1	q_2	q_3	H
Shift Right	↑	H	l (Note 2)	h	l	X	X	L	q_0	q_1	q_2
	↑	H	l (Note 2)	h	h	X	X	H	q_0	q_1	q_2
Parallel Load	↑	H	h	h	X	X	d_n	d_0	d_1	q_2	d_3

NOTES:

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,
   d_n (q_n) = Lower Case Letters Indicate the State of the Referenced Input (or output) One Set-up Time Prior to the Low To High Clock Transition,
   X = Don't Care,
   ↑ = Transition from Low to High Level
2. The High to Low transition of the S0 and S1 Inputs on the CD74HC194, CD74HCT194 should only take place while CP is High for Conventional Operation.

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 . . . . . ±20mA
DC Output Diode Current, I_{OK}
For V_O < -0.5V or V_O > V_{CC} + 0.5V . . . . . ±20mA
DC Output Source or Sink Current per Output Pin, I_O
For V_O > -0.5V or V_O < V_{CC} + 0.5V . . . . . ±25mA
DC V_{CC} or Ground Current, I_{CC} or I_{GND} . . . . . ±50mA

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)

Thermal Information

Thermal Resistance (Typical, Note 3) θ_{JA} (°C/W)
PDIP Package 90
SOIC Package 190
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)

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:

3. 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
High Level Output Voltage TTL Loads			-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			4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	6	-	-	0.26	-	0.33	-	0.4	V

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	
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
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:

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
CP	0.6
$\overline{MR}$	0.55
DSL, DSR, D_n	0.25
Sn	1.10

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	TEST CONDITIONS	V_{CC} (V)	25°C		-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	MAX	MIN	MAX	MIN	MAX	
HC TYPES										
Max. Clock Frequency (Figure 1)	f_{MAX}	-	2	6	-	5	-	4	-	MHz
			4.5	30	-	24	-	20	-	MHz
			6	35	-	28	-	23	-	MHz
$\overline{MR}$ Pulse Width (Figure 2)	t_W	-	2	80	-	100	-	120	-	ns
			4.5	16	-	20	-	24	-	ns
			6	14	-	17	-	20	-	ns
Clock Pulse Width (Figure 1)	t_W	-	2	80	-	100	-	120	-	ns
			4.5	16	-	20	-	24	-	ns
			6	14	-	17	-	20	-	ns
Set-up Time Data to Clock (Figure 3)	t_{SU}	-	2	70	-	90	-	105	-	ns
			4.5	14	-	18	-	21	-	ns
			6	12	-	15	-	19	-	ns
Removal Time, $\overline{MR}$ to Clock (Figure 2)	t_{REM}	-	2	60	-	75	-	90	-	ns
			4.5	12	-	15	-	18	-	ns
			6	10	-	13	-	15	-	ns
Set-Up Time S1, S0 to Clock (Figure 4)	t_{SU}	-	2	80	-	100	-	120	-	ns
			4.5	16	-	20	-	24	-	ns
			6	14	-	17	-	20	-	ns
Set-up Time DSL, DSR to Clock (Figure 4)	t_{SU}	-	2	70	-	90	-	105	-	ns
			4.5	14	-	18	-	21	-	ns
			6	12	-	15	-	18	-	ns
Hold Time S1, S0 to Clock (Figure 4	t_H	-	2	0	-	0	-	0	-	ns
			4.5	0	-	0	-	0	-	ns
			6	0	-	0	-	0	-	ns
Hold Time Data to Clock (Figure 3)	t_H	-	2	0	-	0	-	0	-	ns
			4.5	0	-	0	-	0	-	ns
			6	0	-	0	-	0	-	ns
HCT TYPES										
Max. Clock Frequency (Figure 1)	f_{MAX}	-	4.5	27	-	22	-	18	-	MHz
$\overline{MR}$ Pulse Width (Figure 2)	t_W	-	4.5	16	-	20	-	24	-	ns
Clock Pulse Width (Figure 1)	t_W	-	4.5	16	-	20	-	24	-	ns
Set-up Time, Data to Clock (Figure 3)	t_{SU}	-	4.5	14	-	18	-	21	-	ns
Removal Time $\overline{MR}$ to Clock (Figure 2)	t_{REM}	-	4.5	12	-	15	-	18	-	ns

Prerequisite For Switching Function (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C		-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	MAX	MIN	MAX	MIN	MAX	
Set-up Time S1, S0 to Clock (Figure 4)	t_{SU}	-	4.5	20	-	25	-	30	-	ns
Set-up Time DSL, DSR to Clock (Figure 4)	t_{SU}	-	4.5	14	-	18	-	21	-	ns
Hold Time S1, S0 to Clock (Figure 4)	t_H	-	4.5	0	-	0	-	0	-	ns
Hold Time Data to Clock (Figure 3)	t_H	-	4.5	0	-	0	-	0	-	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, Clock to Output (Figure 1)	t_{PLH}, t_{PHL}	C_L = 50pF	2	-	175	220	265	ns
			4.5	-	35	44	53	ns
			6	-	30	37	45	ns
Propagation Delay, Clock to Q	t_{PLH}, t_{PHL}	-	5	14	-	-	-	ns
Output Transition Time (Figure 1)	t_{TLH}, t_{THL}	C_L = 50pF	2	-	75	95	110	ns
			4.5	-	15	19	22	ns
			6	-	13	16	19	ns
Propagation Delay, $\overline{MR}$ to Output (Figure 2)	t_{PHL}	C_L = 50pF	2	-	140	175	210	ns
			4.5	-	28	35	42	ns
			6	-	24	30	36	ns
Input Capacitance	C_{IN}	-	-	-	10	10	10	pF
Maximum Clock Frequency	f_{MAX}	-	5	60	-	-	-	MHz
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	55	-	-	-	pF
HCT TYPES								
Propagation Delay, Clock to Output (Figure 1)	t_{PLH}, t_{PHL}	C_L = 50pF	4.5	-	37	46	56	ns
Propagation Delay, Clock to Q	t_{PLH}, t_{PHL}	-	5	15	-	-	-	ns
Output Transition Times (Figure 1)	t_{TLH}, t_{THL}	C_L = 50pF	4.5	-	15	19	22	ns
Propagation Delay, $\overline{MR}$ to Output (Figure 2)	t_{PHL}	C_L = 50pF	4.5	-	40	50	60	ns
Input Capacitance	C_{IN}	-	-	-	10	10	10	pF
Maximum Clock Frequency	f_{MAX}	-	5	50	-	-	-	MHz
Power Dissipation Capacitance (Notes 5, 6)	C_{PD}	-	5	60	-	-	-	pF

NOTES:

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

Test Circuits and Waveforms

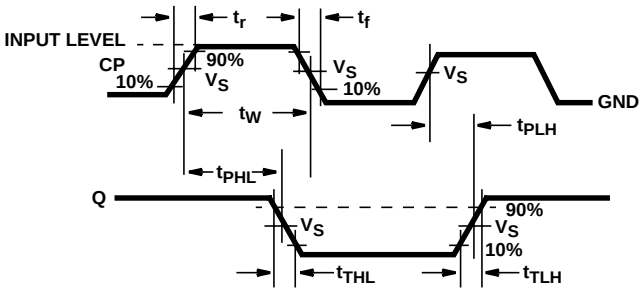


FIGURE 1. CLOCK PRE-REQUISITE TIMES AND PROPAGATION AND OUTPUT TRANSITION TIMES

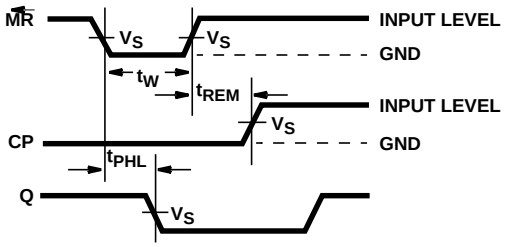


FIGURE 2. MASTER RESET PRE-REQUISITE TIMES AND PROPAGATION DELAYS

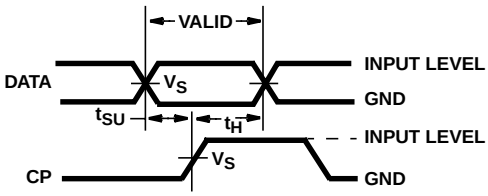


FIGURE 3. DATA PRE-REQUISITE TIMES

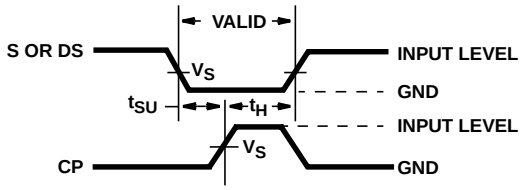


FIGURE 4. PARALLEL LOAD OR SHIFT-LEFT/SHIFT-RIGHT PRE-REQUISITE TIMES

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