National Semiconductor

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MM54HC165/MM74HC165
Parallel-in/Serial-out 8-Bit Shift Register

General Description

The MM54HC165/MM74HC165 high speed PARALLEL-IN/SERIAL-OUT SHIFT REGISTER utilizes advanced silicon-gate CMOS technology. It has the low power consumption and high noise immunity of standard CMOS integrated circuits, along with the ability to drive 10 LS-TTL loads.

This 8-bit serial shift register shifts data from Q_A to Q_H when clocked. Parallel inputs to each stage are enabled by a low level at the SHIFT/LOAD input. Also included is a gated CLOCK input and a complementary output from the eighth bit.

Clocking is accomplished through a 2-input NOR gate permitting one input to be used as a CLOCK INHIBIT function. Holding either of the CLOCK inputs high inhibits clocking, and holding either CLOCK input low with the SHIFT/LOAD input high enables the other CLOCK input. Data transfer occurs on the positive going edge of the clock. Parallel loading is inhibited as long as the SHIFT/LOAD input is high. When taken low, data at the parallel inputs is loaded directly into the register independent of the state of the clock.

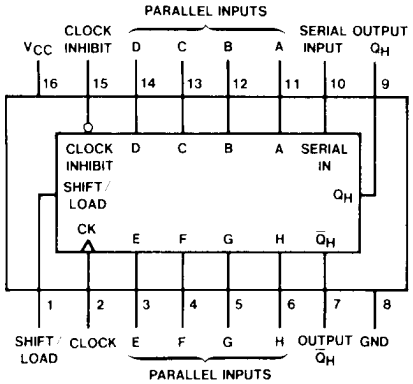
The 54HC/74HC logic family is functionally as well as pin-out compatible with the standard 54LS/74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to V_{CC} and ground.

Features

- Typical propagation delay: 20 ns (clock to Q)
- Wide operating supply voltage range: 2–6V
- Low input current: 1 μA maximum
- Low quiescent supply current: 80 μA maximum (74HC Series)
- Fanout of 10 LS-TTL loads

Connection Diagram

Dual-In-Line Package



TL/F/5316–1

Top View

Order Number MM54HC165 or MM74HC165

Function Table

Inputs					Internal Outputs		Output Q_H
Shift/ Load	Clock Inhibit	Clock	Serial	Parallel A . . . H	Q_A	Q_B	
L	X	X	X	a . . . h	a	b	h
H	L	L	X	X	Q_{A0}	Q_{B0}	Q_{H0}
H	L	↑	H	X	H	Q_{AN}	Q_{GN}
H	L	↑	L	X	L	Q_{AN}	Q_{GN}
H	H	X	X	X	Q_{A0}	Q_{B0}	Q_{H0}

H = High Level (steady state), L = Low Level (steady state)

X = Irrelevant (any input, including transitions)

↑ = Transition from low to high level

Q_{A0}, Q_{B0}, Q_{H0} = The level of Q_A, Q_B, or Q_H, respectively, before the indicated steady-state input conditions were established.

Q_{AN}, Q_{GN} = The level of Q_A or Q_G before the most recent ↑ transition of the clock; indicates a one-bit shift.

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Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{CC})	−0.5 to +7.0V
DC Input Voltage (V_{IN})	−1.5 to V_{CC} +1.5V
DC Output Voltage (V_{OUT})	−0.5 to V_{CC} +0.5V
Clamp Diode Current (I_{IK}, I_{OK})	±20 mA
DC Output Current, per pin (I_{OUT})	±25 mA
DC V_{CC} or GND Current, per pin (I_{CC})	±50 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C
Power Dissipation (P_D) (Note 3)	600 mW
S.O. Package only	500 mW
Lead Temperature (T_L) (Soldering 10 seconds)	260°C

Operating Conditions

		Min	Max	Units
Supply Voltage (V_{CC})		2	6	V
DC Input or Output Voltage (V_{IN}, V_{OUT})		0	V_{CC}	V
Operating Temp. Range (T_A)				
MM74HC		−40	+85	°C
MM54HC		−55	+125	°C
Input Rise or Fall Times (t_r, t_f)	V_{CC} = 2.0V		1000	ns
	V_{CC} = 4.5V		500	ns
	V_{CC} = 6.0V		400	ns

DC Electrical Characteristics (Note 4)

Symbol	Parameter	Conditions	V_{CC}	T_A = 25°C	74HC T_A = −40 to 85°C	54HC T_A = −55 to 125°C	Units
				Typ	Guaranteed Limits		
V_{IH}	Minimum High Level Input Voltage		2.0V		1.5	1.5	1.5	V
			4.5V		3.15	3.15	3.15	V
			6.0V		4.2	4.2	4.2	V
V_{IL}	Maximum Low Level Input Voltage**		2.0V		0.5	0.5	0.5	V
			4.5V		1.35	1.35	1.35	V
			6.0V		1.8	1.8	1.8	V
V_{OH}	Minimum High Level Output Voltage	V_{IN} = V_{IH} or V_{IL} $\|I_{OUT}\| \leq 20\ \mu A$	2.0V	2.0	1.9	1.9	1.9	V
			4.5V	4.5	4.4	4.4	4.4	V
			6.0V	6.0	5.9	5.9	5.9	V
		V_{IN} = V_{IH} or V_{IL} $\|I_{OUT}\| \leq 4.0$ mA	4.5V	4.2	3.98	3.84	3.7	V
		$\|I_{OUT}\| \leq 5.2$ mA	6.0V	5.7	5.48	5.34	5.2	V
V_{OL}	Maximum Low Level Output Voltage	V_{IN} = V_{IH} or V_{IL} $\|I_{OUT}\| \leq 20\ \mu A$	2.0V	0	0.1	0.1	0.1	V
			4.5V	0	0.1	0.1	0.1	V
			6.0V	0	0.1	0.1	0.1	V
		V_{IN} = V_{IH} or V_{IL} $\|I_{OUT}\| \leq 4.0$ mA	4.5V	0.2	0.26	0.33	0.4	V
		$\|I_{OUT}\| \leq 5.2$ mA	6.0V	0.2	0.26	0.33	0.4	V
I_{IN}	Maximum Input Current	V_{IN} = V_{CC} or GND V_{CC} = 2–6V	6.0V		±0.1	±1.0	±1.0	μA
I_{CC}	Maximum Quiescent Supply Current	V_{IN} = V_{CC} or GND I_{OUT} = 0 μA V_{CC} = 2–6V	6.0V		8.0	80	160	μA

Note 1: Absolute Maximum Ratings are those values beyond which damage to the device may occur.

Note 2: Unless otherwise specified all voltages are referenced to ground.

Note 3: Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C; ceramic "J" package: −12 mW/°C from 100°C to 125°C.

Note 4: For a power supply of 5V ±10% the worst case output voltages (V_{OH}, and V_{OL}) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case V_{IH} and V_{IL} occur at V_{CC} = 5.5V and 4.5V respectively. (The V_{IH} value at 5.5V is 3.85V.) The worst case leakage current (I_{IN}, I_{CC}, and I_{OZ}) occur for CMOS at the higher voltage and so the 6.0V values should be used.

**V_{IL} limits are currently tested at 20% of V_{CC}. The above V_{IL} specification (30% of V_{CC}) will be implemented no later than Q1, CY'89.

AC Electrical Characteristics $V_{CC} = 5V$, $T_A = 25°C$, $C_L = 15$ pF, $t_r = t_f = 6$ ns

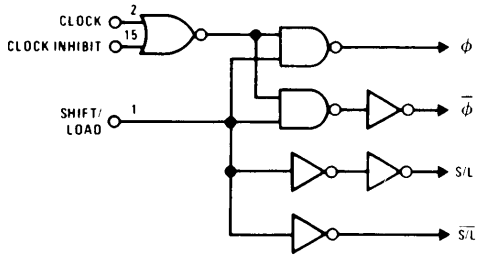
Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
f_{MAX}	Maximum Operating Frequency		50	30	MHz
t_{PHL}, t_{PLH}	Maximum Propagation Delay H to Q_H or $\overline{Q}_H$		15	25	ns
t_{PHL}, t_{PLH}	Maximum Propagation Delay Serial Shift/Parallel Load to Q_H		13	25	ns
t_{PHL}, t_{PLH}	Maximum Propagation Delay Clock to Output		15	25	ns
t_S	Minimum Setup Time Serial Input to Clock, Parallel or Data to Shift/Load		10	20	ns
t_S	Minimum Setup Time Shift/Load to Clock		11	20	ns
t_S	Minimum Setup Time Clock Inhibit to Clock		10	20	ns
t_H	Minimum Hold Time Serial Input to Clock or Parallel Data to Shift/Load			0	ns
t_W	Minimum Pulse Width Clock			16	ns

AC Electrical Characteristics $C_L = 50$ pF, $t_r = t_f = 6$ ns (unless otherwise specified)

Symbol	Parameter	Conditions	V_{CC}	$T_A = 25°C$		74HC $T_A = -40$ to $85°C$	54HC $T_A = -55$ to $125°C$	Units
				Typ	Guaranteed Limits			
f_{MAX}	Maximum Operating Frequency		2.0V 4.5V 6.0V	10 45 50	5 27 32	4 21 25	4 18 21	MHz MHz MHz
t_{PHL}, t_{PLH}	Maximum Propagation Delay H to Q_H or $\overline{Q}_H$		2.0V 4.5V 6.0V	70 21 18	150 30 26	189 38 33	225 45 39	ns ns ns
t_{PHL}, t_{PLH}	Maximum Propagation Delay Serial Shift/ Parallel Load to Q_H		2.0V 4.5V 6.0V	70 21 18	175 35 30	220 44 37	260 52 44	ns ns ns
t_{PHL}, t_{PLH}	Maximum Propagation Delay Clock to Output		2.0V 4.5V 6.0V	70 21 18	150 30 26	189 38 33	225 45 39	ns ns ns
t_S	Minimum Setup Time Serial Input to Clock, or Parallel Data to Shift/Load		2.0V 4.5V 6.0V	35 11 9	100 20 17	125 25 21	150 30 25	ns ns ns
t_S	Minimum Setup Time Shift/Load to Clock		2.0V 4.5V 6.0V	38 12 9	100 20 17	125 25 21	150 30 25	ns ns ns
t_S	Minimum Setup Time Clock Inhibit to Clock		2.0V 4.5V 6.0V	35 11 9	100 20 17	125 25 21	150 30 25	ns ns ns
t_H	Minimum Hold Time Serial Input to Clock or Parallel Data to Shift/Load		2.0V 4.5V 6.0V		0 0 0	0 0 0	0 0 0	ns ns ns
t_W	Minimum Pulse Width, Clock		2.0V 4.5V 6.0V	30 9 8	80 16 14	100 20 18	120 24 20	ns ns ns
t_{THL}, t_{TLH}	Maximum Output Rise and Fall Time		2.0V 4.5V 6.0V	30 9 8	75 15 13	95 19 16	110 22 19	ns ns ns
t_r, t_f	Maximum Input Rise and Fall Time		2.0V 4.5V 6.0V		1000 500 400	1000 500 400	1000 500 400	ns ns ns
C_{PD}	Power Dissipation Capacitance (Note 5)	(per package)		100				pF
C_{IN}	Maximum Input Capacitance			5	10	10	10	pF

Note 5: C_{PD} determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_S = C_{PD} V_{CC} f + I_{CC}$.

Logic Diagrams



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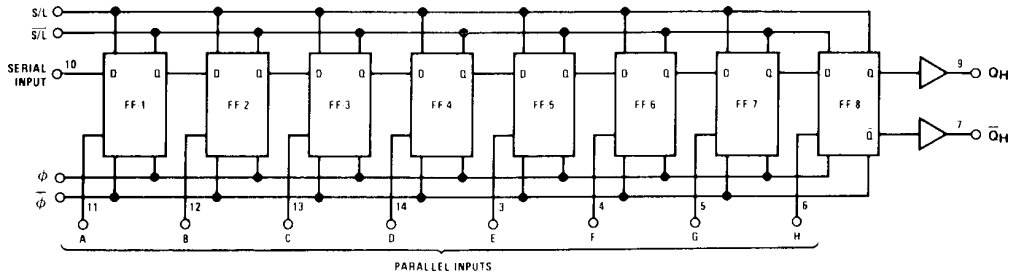

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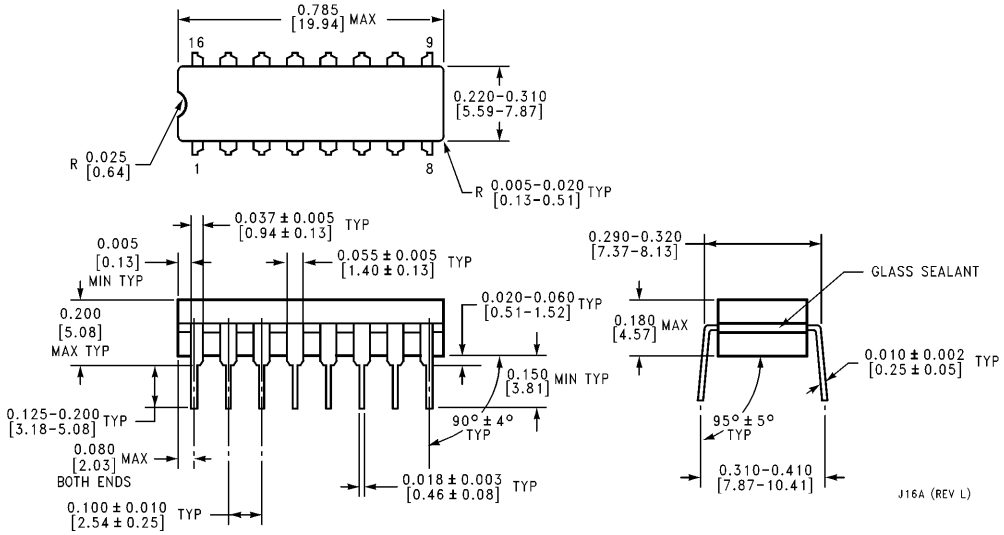
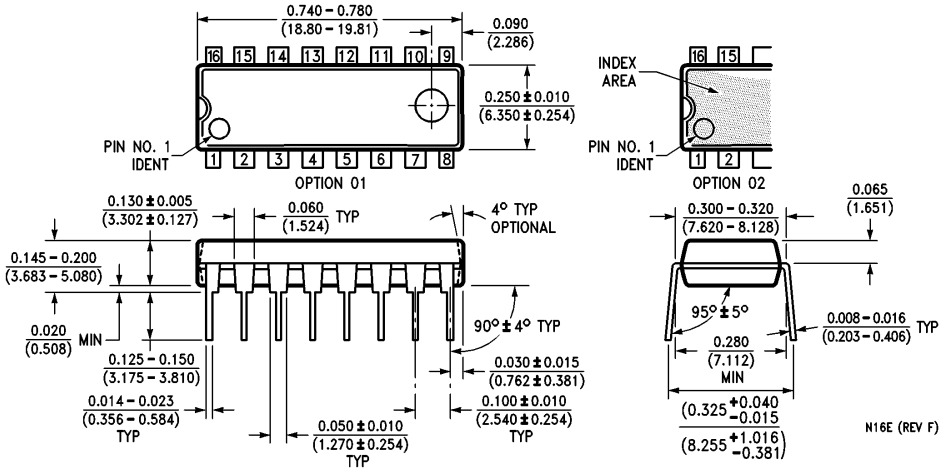
Physical Dimensions inches (millimeters)



Dual-In-Line Package
Order Number MM54HC165J or MM74HC165J
NS Package J16A

Physical Dimensions inches (millimeters) (Continued)



Dual-In-Line Package
Order Number MM74HC165N
NS Package N16E

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National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408