

## 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 load-

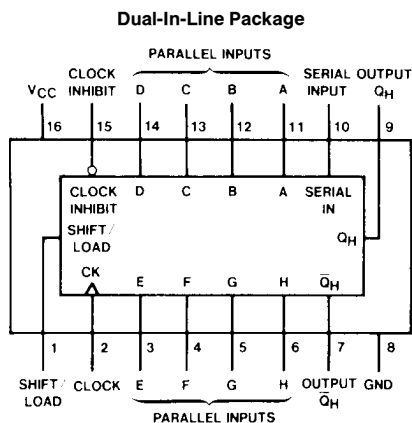
ing is inhibited as long as the SHIFT/LOAD input is high. When taken low, data at the parallel inputs is loaded directly into the register independent of the state of the clock.

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  $\mu$ A maximum
- Low quiescent supply current: 80  $\mu$ A maximum (74HC Series)
- Fanout of 10 LS-TTL loads

### Connection Diagram



TL/F/5316-1

Order Number MM54HC165 or MM74HC165

### Function Table

| Shift/Load | Clock Inhibit | Clock      | Serial | Inputs                | Internal Outputs |          | Output $Q_H$ |
|------------|---------------|------------|--------|-----------------------|------------------|----------|--------------|
|            |               |            |        | Parallel<br>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             | $\uparrow$ | H      | X                     | H                | $Q_{AN}$ | $Q_{GN}$     |
| H          | L             | $\uparrow$ | 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)

$\uparrow$  = 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  $\uparrow$  transition of the clock; indicates a one-bit shift.

**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 <sub>CC</sub> | T <sub>A</sub> = 25°C |                   | 74HC                         | 54HC                          | Units |
|-----------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------|-------------------|------------------------------|-------------------------------|-------|
|                 |                                   |                                                                                                                      |                 |                       |                   | T <sub>A</sub> = −40 to 85°C | T <sub>A</sub> = −55 to 125°C |       |
|                 |                                   |                                                                                                                      |                 | Typ                   | Guaranteed Limits |                              |                               |       |
| V <sub>IH</sub> | 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 <sub>IL</sub> | 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 <sub>OH</sub> | Minimum High Level Output Voltage | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 20 μA                                  | 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 <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 4.0 mA<br> I <sub>OUT</sub>   ≤ 5.2 mA | 4.5V            | 4.2                   | 3.98              | 3.84                         | 3.7                           | V     |
|                 |                                   |                                                                                                                      | 6.0V            | 5.7                   | 5.48              | 5.34                         | 5.2                           | V     |
|                 |                                   |                                                                                                                      |                 |                       |                   |                              |                               |       |
| V <sub>OL</sub> | Maximum Low Level Output Voltage  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 20 μA                                  | 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 <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 4.0 mA<br> I <sub>OUT</sub>   ≤ 5.2 mA | 4.5V            | 0.2                   | 0.26              | 0.33                         | 0.4                           | V     |
|                 |                                   |                                                                                                                      | 6.0V            | 0.2                   | 0.26              | 0.33                         | 0.4                           | V     |
|                 |                                   |                                                                                                                      |                 |                       |                   |                              |                               |       |
| I <sub>IN</sub> | Maximum Input Current             | V <sub>IN</sub> = V <sub>CC</sub> or GND<br>V <sub>CC</sub> = 2–6V                                                   | 6.0V            |                       | ± 0.1             | ± 1.0                        | ± 1.0                         | μA    |
| I <sub>CC</sub> | Maximum Quiescent Supply Current  | V <sub>IN</sub> = V <sub>CC</sub> or GND<br>I <sub>OUT</sub> = 0 μA<br>V <sub>CC</sub> = 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 $V_{CC} = 5V$ , $T_A = 25^\circ C$ , $C_L = 15\text{ pF}$ , $t_r = t_f = 6\text{ ns}$

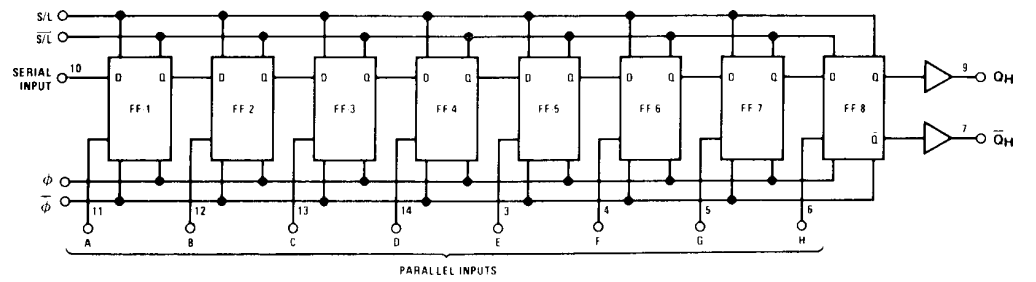
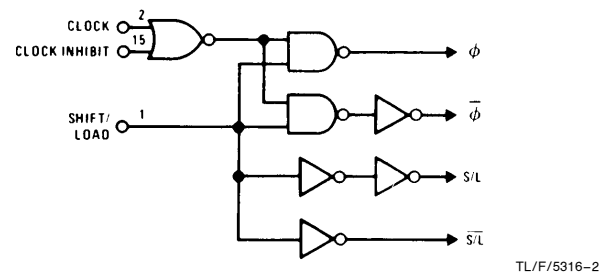
| Symbol                | Parameter                                                                | Conditions | Typ | Guaranteed Limit | Units |
|-----------------------|--------------------------------------------------------------------------|------------|-----|------------------|-------|
| $f_{MAX}$             | Maximum Operating Frequency                                              |            | 50  | 30               | MHz   |
| $t_{PHL}$ , $t_{PLH}$ | Maximum Propagation Delay H to $Q_H$ or $\bar{Q}_H$                      |            | 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 $C_L = 50\text{ pF}$ , $t_r = t_f = 6\text{ ns}$ (unless otherwise specified)

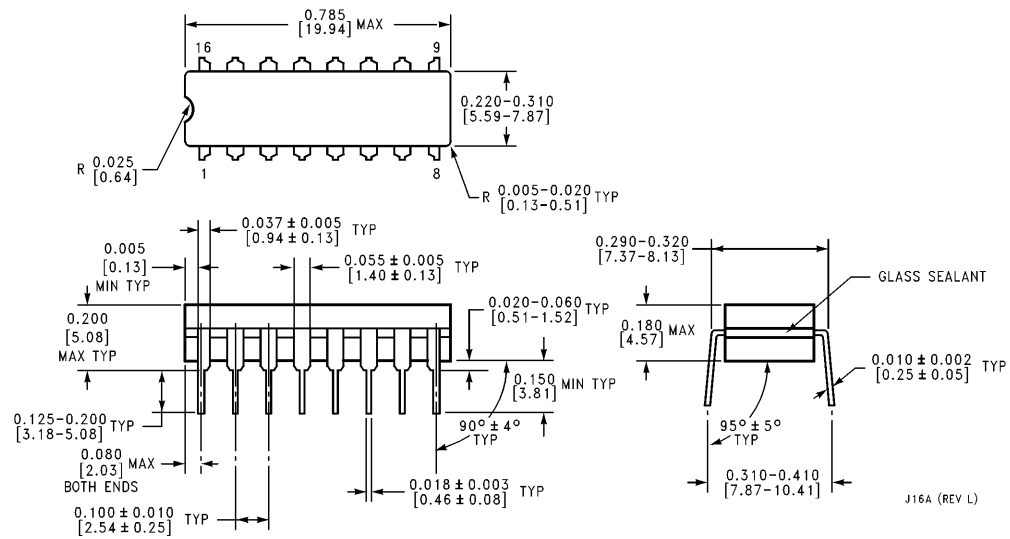
| Symbol                              | Parameter                                                                | Conditions    | V <sub>CC</sub> | T <sub>A</sub> = 25°C |                   | 74HC | 54HC | Units |
|-------------------------------------|--------------------------------------------------------------------------|---------------|-----------------|-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

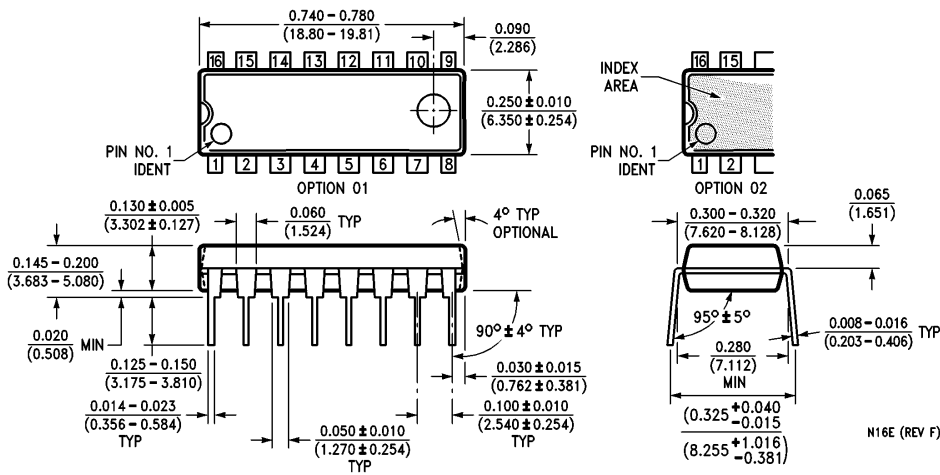
## Logic Diagrams



# 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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