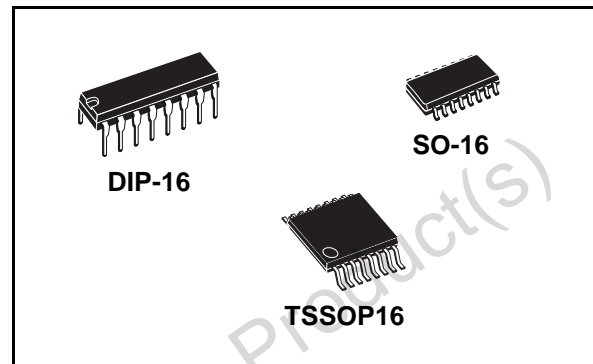


8-bit PISO shift register

Features

- High speed:
 - $t_{PD} = 15 \text{ ns}$ (typ.) at $V_{CC} = 6 \text{ V}$
- Low power dissipation:
 - $I_{CC} = 4 \mu\text{A}$ (max.) at $T_A = 25 \text{ }^\circ\text{C}$
- High noise immunity:
 - $V_{NIH} = V_{NIL} = 28 \% V_{CC}$ (Min.)
- Symmetrical output impedance:
 - $|I_{OH}| = I_{OL} = 4 \text{ mA}$ (min)
- Balanced propagation delays:
 - $t_{PLH} \cong t_{PHL}$
- Wide operating voltage range:
 - $V_{CC} \text{ (opr)} = 2 \text{ V to } 6 \text{ V}$
- Pin and function compatible with 74 series 165



Description

The M74HC165 is a high speed CMOS 8-bit PISO (parallel-in-serial-out) shift register fabricated with silicon gate C²MOS technology. This device contains eight clocked master slave RS flip-flops connected as a shift register, with auxiliary gating to provide overriding asynchronous parallel entry. The parallel data enter when the shift/load input is low and can change while shift/load is low, provided that the recommended set-up and hold times are observed. For clocked operation, shift/load must be high. The two clock inputs perform identically: one can be used as a clock inhibit by applying a high signal, to allow this operation clocking is accomplished through a 2-input nor gate. To avoid double clocking, however, the inhibit signal should only go high while the clock is high. Otherwise the rising inhibit signal causes the same response as rising clock edge. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

Table 1. Device summary

| Order code | Package | Packaging |
|----------------|---------|---------------|
| M74HC165B1R | DIP-16 | Tube |
| M74HC165RM13TR | SO-16 | Tape and reel |
| M74HC165TTR | TSSOP16 | Tape and reel |

Contents

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1 Logic symbols and I/O equivalent circuit

Figure 1. IEC logic symbols

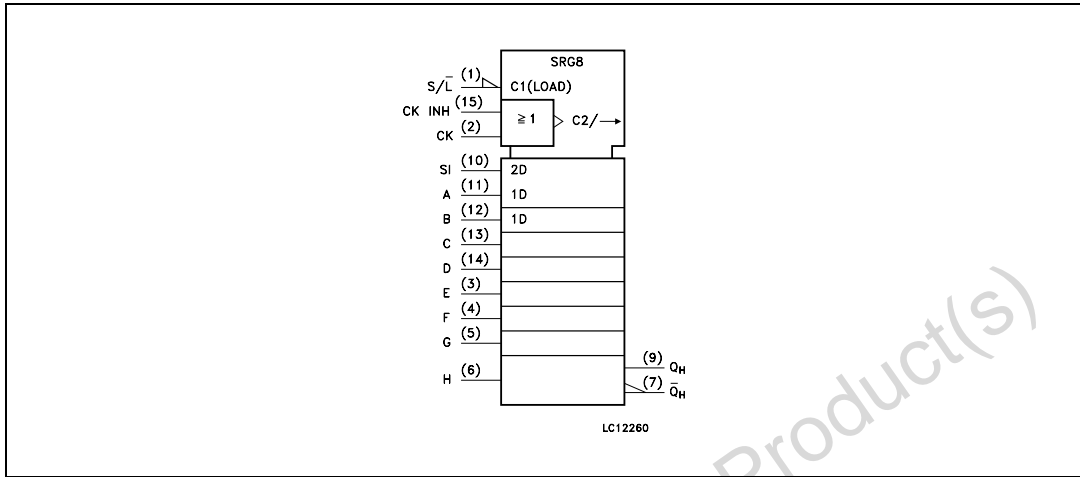
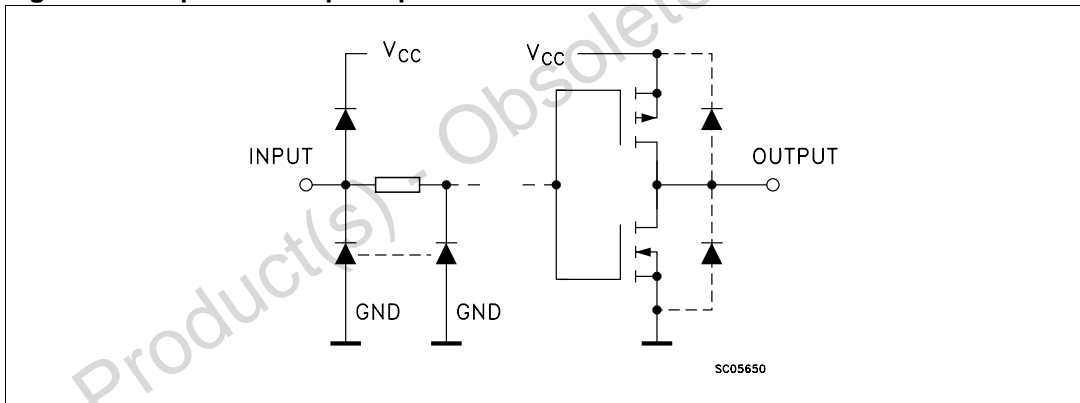


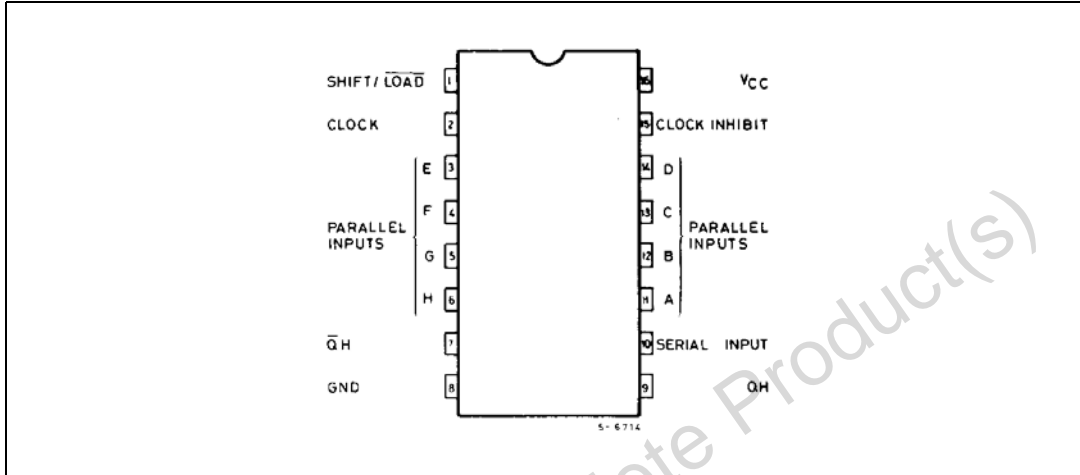
Figure 2. Input and output equivalent circuit



2 Pin settings

2.1 Pin connection

Figure 3. Pin connection (top through view)



2.2 Pin description

Table 2. Pin description

| Pin number | Symbol | Name and function |
|----------------------------|---------------------------------|---|
| 1 | SHIFT/ $\overline{\text{LOAD}}$ | Data inputs |
| 2 | CLOCK | Clock input (low to high, edge triggered) |
| 7 | $\overline{\text{QH}}$ | Complementary output |
| 9 | QH | Serial output |
| 10 | SI | Serial input |
| 11, 12, 13, 14, 3, 4, 5, 6 | A to H | Parallel data inputs |
| 15 | CLOCK INH | Clock inhibit |
| 8 | GND | Ground (0 V) |
| 16 | V _{CC} | Positive supply voltage |

3 Logic states

3.1 Truth table

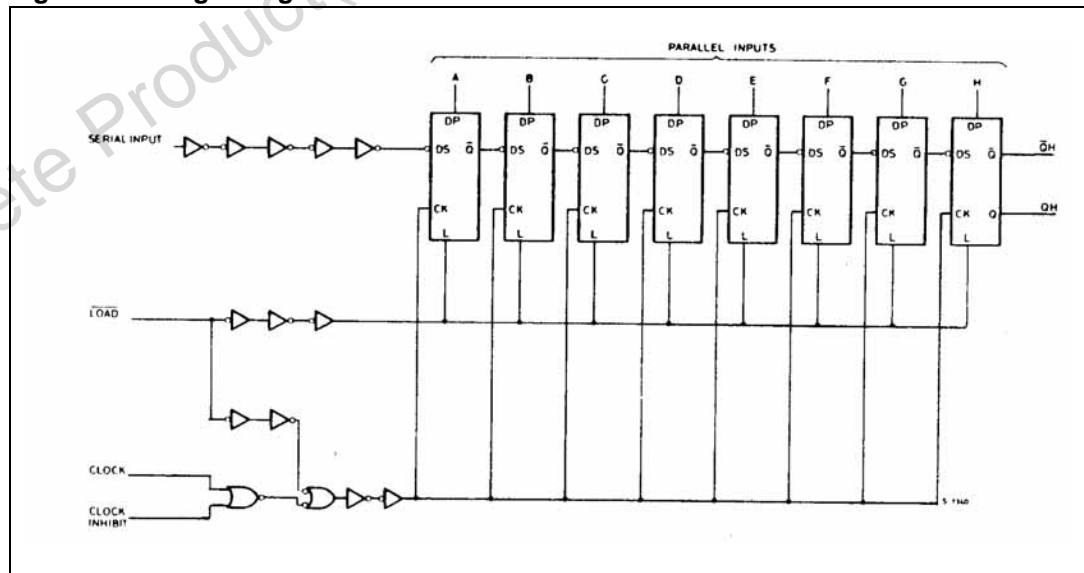
Table 3. Truth table

| Inputs | | | | | Internal outputs | | Outputs |
|---------------------------------------|-----------|----------|----|---------|------------------|-----|---------|
| $\overline{\text{Shift}}/\text{Load}$ | Clock INH | Clock | SI | A.....H | QA | QB | QH |
| L | X | X | X | a.....h | a | b | h |
| H | L | \lceil | H | X | H | QAn | QGn |
| H | L | \lceil | L | X | L | QAn | QGn |
| H | \lceil | L | H | X | H | QAn | QGn |
| H | \lceil | L | L | X | L | QAn | QGn |
| H | X | H | X | X | No change | | |
| H | H | X | X | X | No change | | |

Note: *a.....h* : the level of steady input voltage at inputs a through respectively QAn - QGn : the level of QA - QG, respectively. Before the most recent transition of the clock.

3.2 Logic diagram

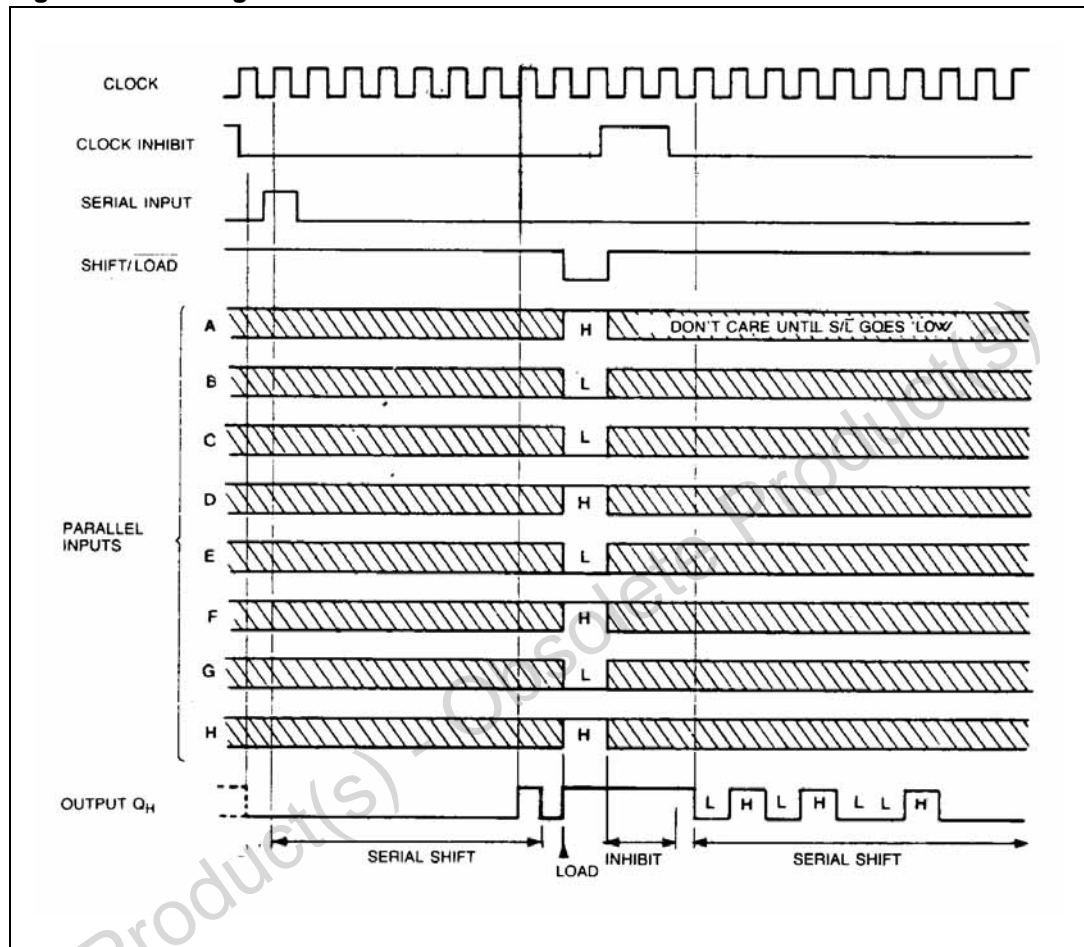
Figure 4. Logic diagram



Note: This logic diagram has not to be used to estimate propagation delays

3.3 Timing chart

Figure 5. Timing chart



4 Maximum rating

Stressing the device above the rating listed in the “absolute maximum ratings” table may cause permanent damage to the device. these are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. exposure to absolute maximum rating conditions for extended periods may affect device reliability. refer also to the STMicroelectronics sure program and other relevant quality documents.

Table 4. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|-----------------------|-------------------------------|------------------------|------|
| V_{CC} | Supply voltage | -0.5 to +7 | V |
| V_I | DC input voltage | -0.5 to $V_{CC} + 0.5$ | V |
| V_O | DC output voltage | -0.5 to $V_{CC} + 0.5$ | V |
| I_{IK} | DC input diode current | ± 20 | mA |
| I_{OK} | DC output diode current | ± 20 | mA |
| I_O | DC output current | ± 25 | mA |
| I_{CC} or I_{GND} | DC V_{CC} or ground current | ± 50 | mA |
| P_D | Power dissipation | 500 ⁽¹⁾ | mW |
| T_{stg} | Storage temperature | -65 to +150 | °C |
| T_L | Lead temperature (10 sec) | 300 | °C |

1. (*) 500 mW at 65 °C; derate to 300 mW by 10 mW/°C from 65°C to 85°C

4.1 Recommended operating conditions

Table 5. Recommended operating conditions

| Symbols | Parameter | Value | Unit | |
|------------|--------------------------|------------------|-----------|----|
| V_{CC} | Supply voltage | 2 to 6 | V | |
| V_I | Input voltage | 0 to V_{CC} | V | |
| V_O | Output voltage | 0 to V_{CC} | V | |
| T_{op} | Operating temperature | -55 to 125 | °C | |
| t_r, t_f | Input rise and fall time | $V_{CC} = 2.0$ V | 0 to 1000 | ns |
| | | $V_{CC} = 4.5$ V | 0 to 500 | ns |
| | | $V_{CC} = 6.0$ V | 0 to 400 | ns |

5 Electrical characteristics

Table 6. DC specifications

| Symbol | Parameter | Test condition | | Value | | | | | | Unit | |
|-----------------|---------------------------|------------------------|---|-----------------------|------|------|-------------|------|--------------|------|-----|
| | | V _{CC} (V) | | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | | Max |
| V _{IH} | High level input voltage | 2.0 | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 4.5 | | 3.15 | | | 3.15 | | 3.15 | | |
| | | 6.0 | | 4.2 | | | 4.2 | | 4.2 | | |
| V _{IL} | Low level input voltage | 2.0 | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 4.5 | | | | 1.35 | | 1.35 | | 1.35 | |
| | | 6.0 | | | | 1.8 | | 1.8 | | 1.8 | |
| V _{OH} | High level output voltage | 2.0 | I _O = -20 μA | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 4.5 | I _O = -20 μA | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 6.0 | I _O = -20 μA | 5.9 | 6.0 | | 5.9 | | 5.9 | | |
| | | 4.5 | I _O = -4.0 mA | 4.18 | 4.31 | | 4.13 | | 4.10 | | |
| | | 6.0 | I _O = -5.2 mA | 5.68 | 5.8 | | 5.63 | | 5.60 | | |
| V _{OL} | Low level output voltage | 2.0 | I _O = 20 μA | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | I _O = 20 μA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | I _O = 20 μA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | I _O = 4.0 mA | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | I _O = 5.2 mA | | 0.18 | 0.26 | | 0.33 | | 0.40 | |
| I _I | Input leakage current | 6.0 | V _I = V _{CC} or GND | | | ±0.1 | | ±1 | | ±1 | μA |
| I _{CC} | Quiescent supply current | 6.0 | V _I = V _{CC} or GND | | | 4 | | 40 | | 80 | μA |

Table 7. AC electrical characteristics ($C_L = 50$ pF, Input $t_r = t_f = 6$ ns)

| Symbol | Parameter | Test condition | | Value | | | | | | Unit | |
|--------------------------|--|-----------------|--|--------------------------|-----|-----|-----------------------------|-----|------------------------------|------|-----|
| | | V_{CC} (V) | | $T_A = 25^\circ\text{C}$ | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | | Max |
| t_{TLH} t_{THL} | Output transition time | 2.0 | | | 30 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | | 7 | 13 | | 16 | | |
| t_{PLH} t_{PHL} | Propagation delay time (CLOCK - QH, \overline{QH}) | 2.0 | | | 55 | 150 | | 190 | | 225 | ns |
| | | 4.5 | | | 18 | 30 | | 38 | | 45 | |
| | | 6.0 | | | | 15 | 26 | | 33 | | |
| t_{PLH} t_{PHL} | Propagation delay time (SHIFT/ \overline{LOAD} - QH, \overline{QH}) | 2.0 | | | 65 | 165 | | 205 | 250 | | ns |
| | | 4.5 | | | 21 | 33 | | 41 | | 50 | |
| | | 6.0 | | | | 18 | 28 | | 35 | | |
| t_{PLH} t_{PHL} | Propagation delay time (H - QH, \overline{QH}) | 2.0 | | | 52 | 135 | | 170 | | 205 | ns |
| | | 4.5 | | | 17 | 27 | | 34 | | 41 | |
| | | 6.0 | | | | 14 | 23 | | 29 | | |
| f_{MAX} | Maximum clock frequency | 2.0 | | 7.4 | 15 | | 6.0 | | 4.8 | | MHz |
| | | 4.5 | | 37 | 60 | | 30 | | 24 | | |
| | | 6.0 | | 44 | 71 | | 35 | | 28 | | |
| $t_{W(H)}$ $t_{W(L)}$ | Minimum pulse width (CLOCK) | 2.0 | | | 24 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 6 | 15 | | 19 | | 22 | |
| | | 6.0 | | | | 5 | 13 | | 16 | | |
| $t_{W(L)}$ | Minimum pulse width (SHIFT/ \overline{LOAD}) | 2.0 | | | 32 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | | 7 | 13 | | 16 | | |
| t_s | Minimum set-up time (PI - SHIFT/ \overline{LOAD}) (SI - CLOCK) (SHIFT/ \overline{LOAD} - CK) | 2.0 | | | 24 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 6 | 15 | | 19 | | 22 | |
| | | 6.0 | | | | 5 | 13 | | 16 | | |
| t_h | Minimum hold time (PI - SHIFT/ \overline{LOAD}) (SI - CLOCK) (SHIFT/ \overline{LOAD} - CK) | 2.0 | | | | 0 | | 0 | | 0 | ns |
| | | 4.5 | | | | 0 | | 0 | | 0 | |
| | | 6.0 | | | | | 0 | | 0 | | |
| t_{REM} | Minimum removal time (CLOCK - CK INH) | 2.0 | | | 20 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 5 | 15 | | 19 | | 22 | |
| | | 6.0 | | | | 4 | 13 | | 16 | | |

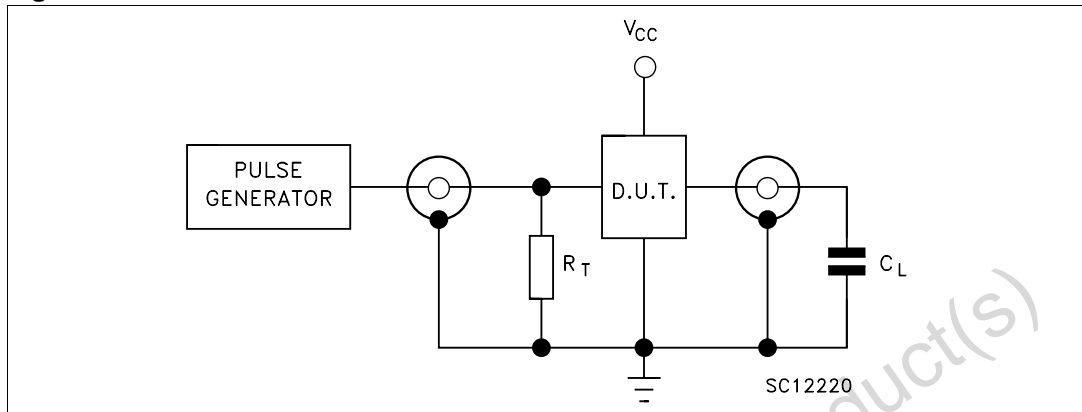
Table 8. Capacitive characteristics

| Symbol | Parameter | Test condition | | Value | | | | | | Unit | |
|-----------------|--|------------------------|--|------------------------|-----|-----|--------------|-----|---------------|------|-----|
| | | V _{CC} (V) | | T _A = 25 °C | | | -40 to 85 °C | | -55 to 125 °C | | |
| | | | | Min | Typ | Max | Min | Max | Min | | Max |
| C _{IN} | Input capacitance | 5.0 | | | 5 | 10 | | 10 | | 10 | pF |
| C _{PD} | Power dissipation capacitance ⁽¹⁾ | 5.0 | | | 55 | | | | | | pF |

1. C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.
 $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

6 Test circuit

Figure 6. Test circuit



$C_L = 50 \text{ pF}$ or equivalent (includes jig and probe capacitance)

$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

7 Waveforms

Figure 7. Serial mode propagation delay (f = 1 MHz; 50% duty cycle)

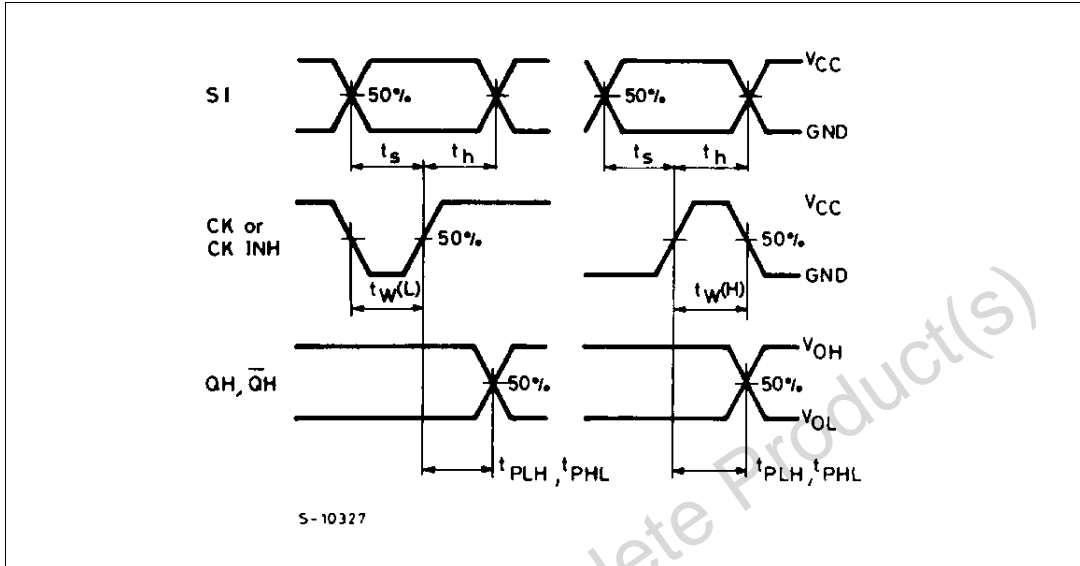


Figure 8. Parallel mode propagation delay (f = 1 MHz; 50% duty cycle)

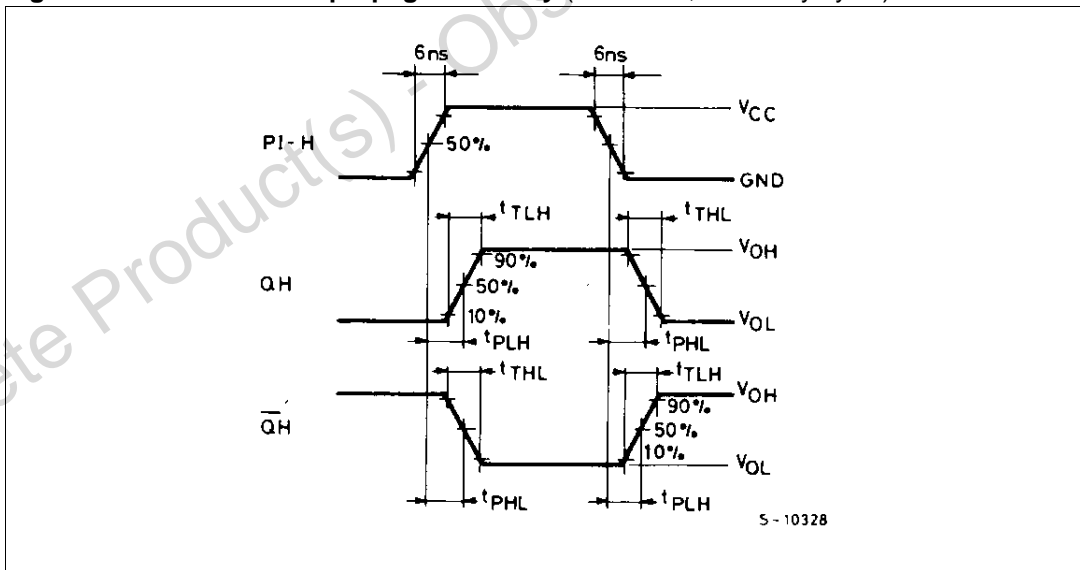


Figure 9. Minimum pulse width (S/\bar{L}), propagation delay times
 ($f = 1\text{ MHz}$; 50% duty cycle)

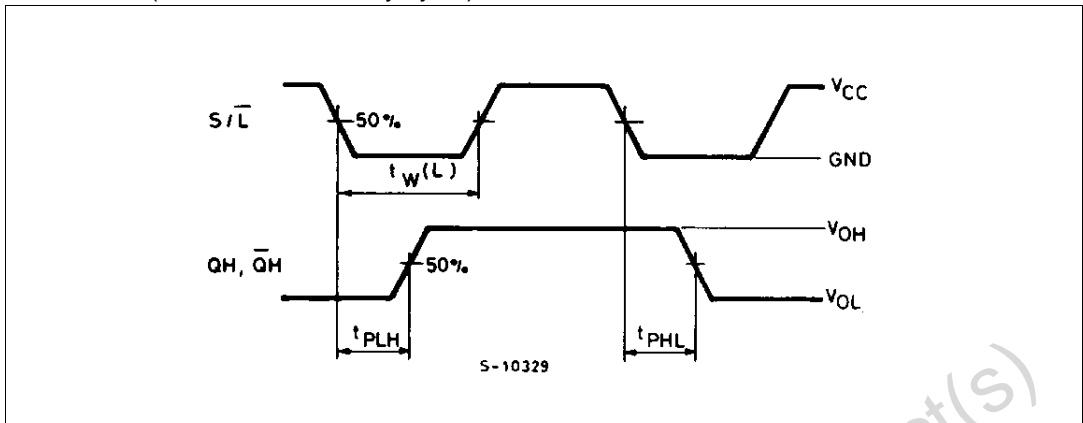


Figure 10. Setup and hold time (PI to S/\bar{L}) ($f = 1\text{ MHz}$; 50% duty cycle)

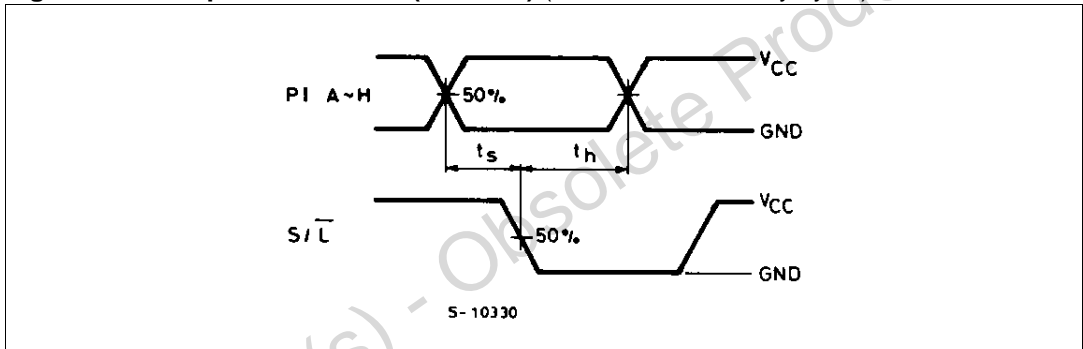
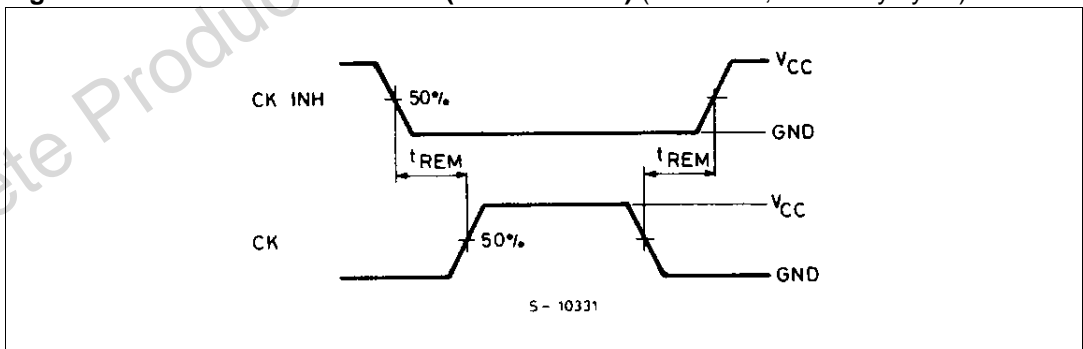


Figure 11. Minimum removal time (CK INH to CK) ($f = 1\text{ MHz}$; 50% duty cycle)



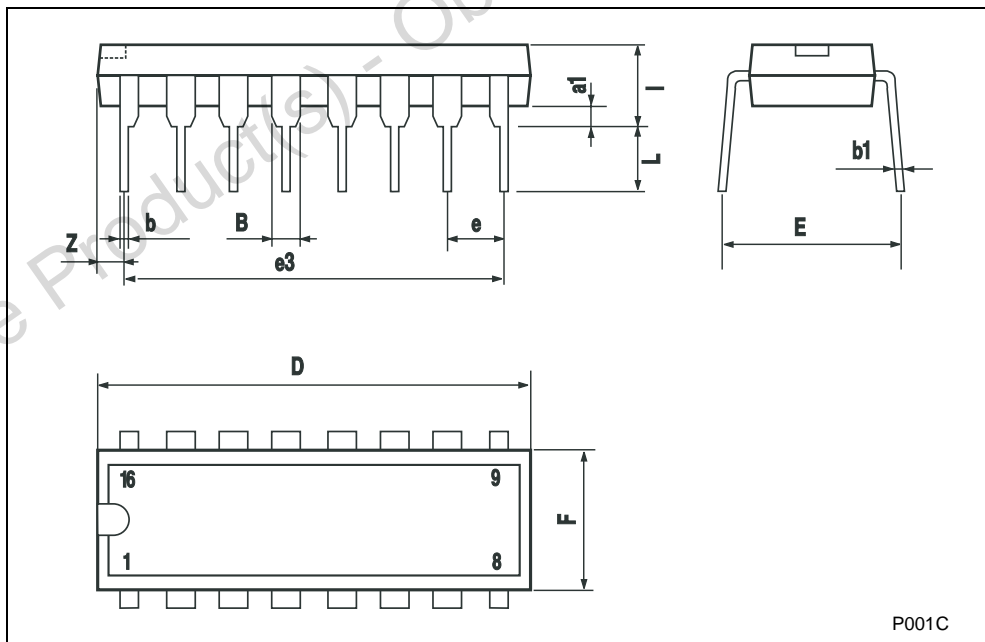
8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

Obsolete Product(s) - Obsolete Product(s)

Plastic DIP-16 (0.25) MECHANICAL DATA

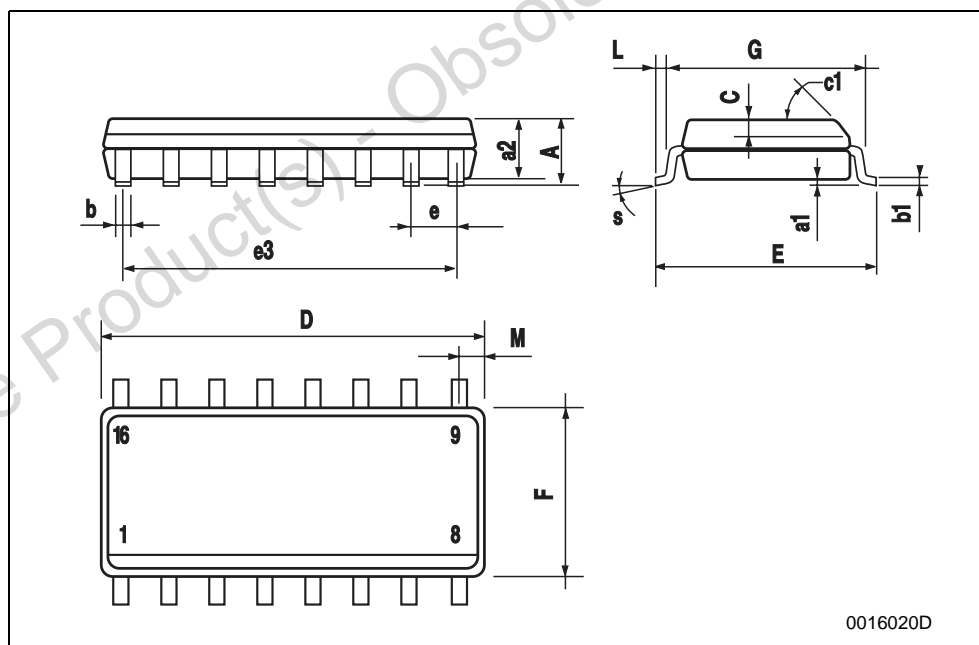
| DIM. | mm. | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| I | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |



P001C

SO-16 MECHANICAL DATA

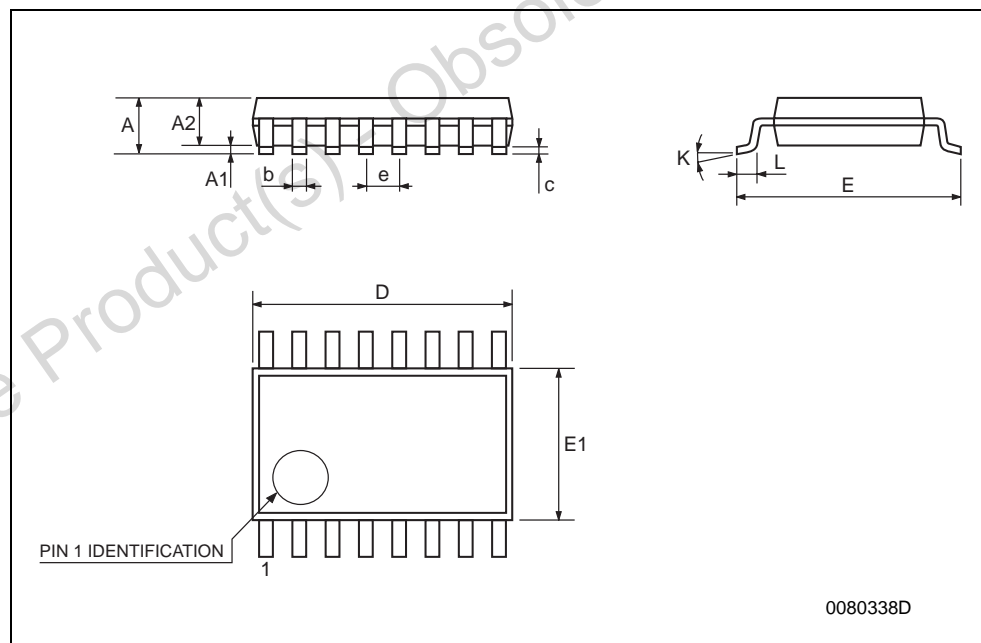
| DIM. | mm. | | | inch | | |
|------|------------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.64 | | | 0.063 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |



0016020D

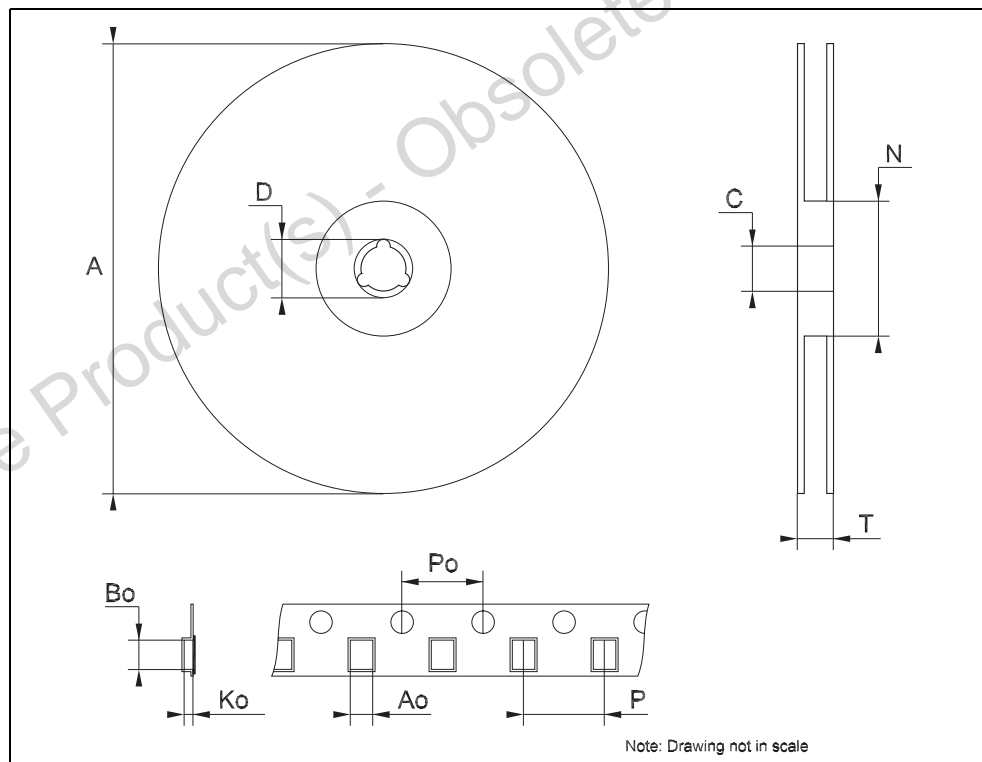
TSSOP16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|----------|------|-------|------------|--------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0079 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



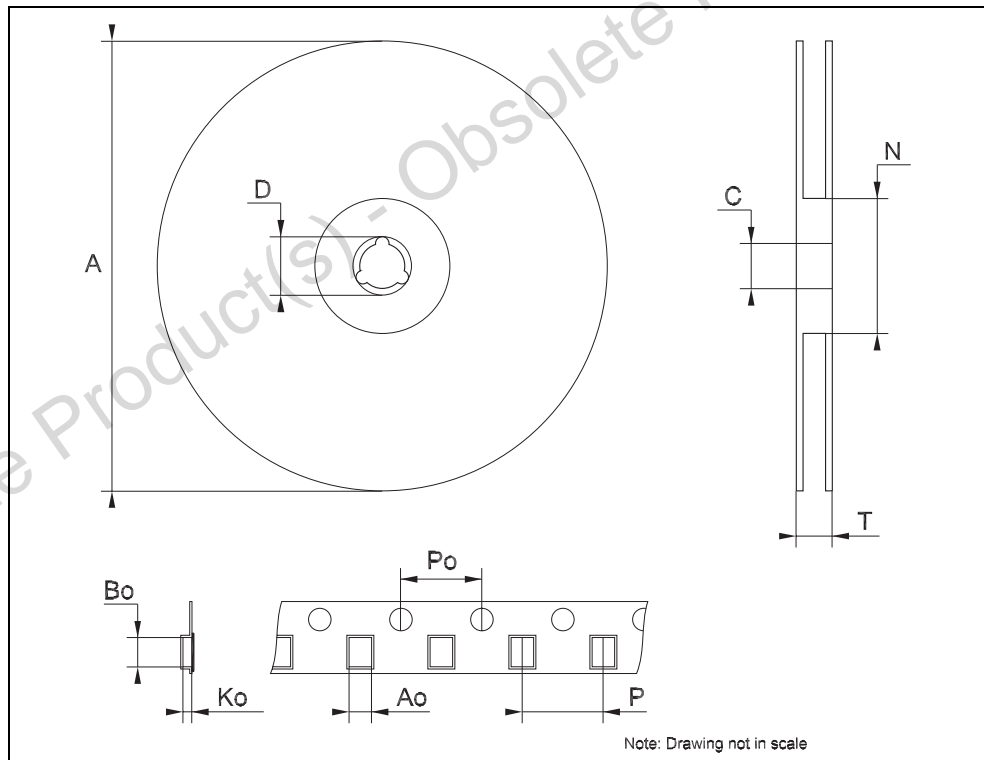
Tape & Reel SO-16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|------|------|-------|------|--------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.45 | | 6.65 | 0.254 | | 0.262 |
| Bo | 10.3 | | 10.5 | 0.406 | | 0.414 |
| Ko | 2.1 | | 2.3 | 0.082 | | 0.090 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |



Tape & Reel SSOP16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|------|------|-------|------|--------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 8.4 | | 8.6 | 0.331 | | 0.339 |
| Bo | 6.7 | | 6.9 | 0.264 | | 0.272 |
| Ko | 2.9 | | 3.1 | 0.114 | | 0.122 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 11.9 | | 12.1 | 0.468 | | 0.476 |



9 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 9-Jul-2001 | 3 | Final release. |
| 21-Mar-2007 | 4 | The document has been reformatted, updated Table 2: Pin description on page 4 |
| 26-May-2008 | 5 | Removed: M74HC165M1R order code. Minor changes in the text. Added: SO-16 and TSSOP16 tape and reel specifications. |

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