

MC74VHC74

Dual D-Type Flip-Flop with Set and Reset

The MC74VHC74 is an advanced high speed CMOS D-type flip-flop fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

The signal level applied to the D input is transferred to Q output during the positive going transition of the Clock pulse.

Reset (\overline{RD}) and Set (\overline{SD}) are independent of the Clock (CP) and are accomplished by setting the appropriate input Low.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output. The inputs tolerate voltages up to 7.0 V, allowing the interface of 5.0 V systems to 3.0 V systems.

Features

- High Speed: $f_{max} = 170\text{MHz}$ (Typ) at $V_{CC} = 5\text{V}$
- Low Power Dissipation: $I_{CC} = 2\mu\text{A}$ (Max) at $T_A = 25^\circ\text{C}$
- High Noise Immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$
- Power Down Protection Provided on Inputs
- Balanced Propagation Delays
- Designed for 2.0 V to 5.5 V Operating Range
- Low Noise: $V_{OLP} = 0.8\text{V}$ (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300 mA
- ESD Performance:
 - Human Body Model > 2000 V;
 - Machine Model > 200 V
- Chip Complexity: 128 FETs or 32 Equivalent Gates
- These Devices are Pb-Free and are RoHS Compliant

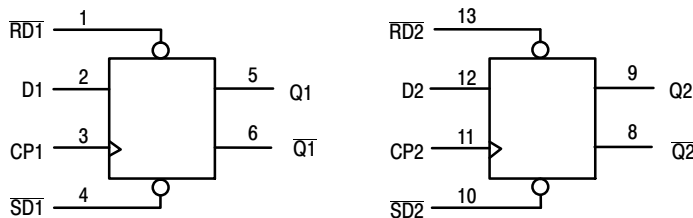


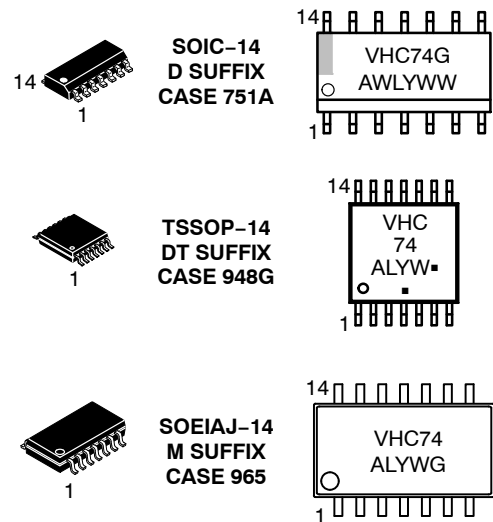
Figure 1. LOGIC DIAGRAM



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MARKING DIAGRAMS



A = Assembly Location
 WL, L = Wafer Lot
 Y, YY = Year
 WW, W = Work Week
 G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

FUNCTION TABLE

| Inputs | | | | Outputs | |
|--------|----|----|---|-----------|----------------|
| SD | RD | CP | D | Q | \overline{Q} |
| L | H | X | X | H | L |
| H | L | X | X | L | H |
| L | L | X | X | H* | H* |
| H | H | ↗ | H | H | L |
| H | H | ↘ | L | L | H |
| H | H | L | X | No Change | No Change |
| H | H | H | X | No Change | No Change |
| H | H | ↔ | X | No Change | No Change |

*Both outputs will remain high as long as Set and Reset are low, but the output states are unpredictable if Set and Reset go high simultaneously.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

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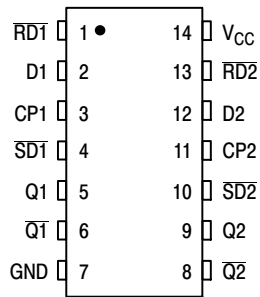


Figure 2. PIN ASSIGNMENT

MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------------|---|--------------------------------|------|
| V _{CC} | DC Supply Voltage | - 0.5 to + 7.0 | V |
| V _{in} | DC Input Voltage | - 0.5 to + 7.0 | V |
| V _{out} | DC Output Voltage | - 0.5 to V _{CC} + 0.5 | V |
| I _{IK} | Input Diode Current | -20 | mA |
| I _{OK} | Output Diode Current | ±20 | mA |
| I _{out} | DC Output Current, per Pin | ±25 | mA |
| I _{CC} | DC Supply Current, V _{CC} and GND Pins | ±50 | mA |
| P _D | Power Dissipation in Still Air, SOIC Packages† TSSOP Package† | 500 450 | mW |
| T _{stg} | Storage Temperature | -65 to +150 | °C |

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range GND ≤ (V_{in} or V_{out}) ≤ V_{CC}. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). Unused outputs must be left open.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

†Derating SOIC Packages: - 7 mW/°C from 65° to 125°C
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit |
|---------------------------------|--|-----|-----------------|------|
| V _{CC} | DC Supply Voltage | 2.0 | 5.5 | V |
| V _{in} | DC Input Voltage | 0 | 5.5 | V |
| V _{out} | DC Output Voltage | 0 | V _{CC} | V |
| T _A | Operating Temperature, All Package Types | -55 | + 125 | °C |
| t _r , t _f | Input Rise and Fall Time | 0 | 100 | ns/V |
| | | 0 | 20 | |

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DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | V _{CC} V | T _A = 25°C | | | T _A = -55°C to +125°C | | Unit |
|-----------------|-----------------------------------|--|----------------------|-------------------------------|-------------------|-------------------------------|----------------------------------|-------------------------------|------|
| | | | | Min | Typ | Max | Min | Max | |
| V _{IH} | Minimum High-Level Input Voltage | | 2.0 3.0 to 5.5 | 1.50 V _{CC} × 0.7 | | | 1.50 V _{CC} × 0.7 | | V |
| V _{IL} | Maximum Low-Level Input Voltage | | 2.0 3.0 to 5.5 | | | 0.50 V _{CC} × 0.3 | | 0.50 V _{CC} × 0.3 | V |
| V _{OH} | Minimum High-Level Output Voltage | V _{in} = V _{IH} or V _{IL} I _{OH} = - 50μA | 2.0 3.0 4.5 | 1.9 2.9 4.4 | 2.0 3.0 4.5 | | 1.9 2.9 4.4 | | V |
| | | V _{in} = V _{IH} or V _{IL} I _{OH} = - 4mA I _{OH} = - 8mA | 3.0 4.5 | 2.58 3.94 | | | 2.48 3.80 | | |
| V _{OL} | Maximum Low-Level Output Voltage | V _{in} = V _{IH} or V _{IL} I _{OL} = 50μA | 2.0 3.0 4.5 | | 0.0 0.0 0.0 | 0.1 0.1 0.1 | | 0.1 0.1 0.1 | V |
| | | V _{in} = V _{IH} or V _{IL} I _{OL} = 4mA I _{OL} = 8mA | 3.0 4.5 | | | 0.36 0.36 | 0.44 0.44 | | |
| I _{in} | Maximum Input Leakage Current | V _{in} = 5.5V or GND | 0 to 5.5 | | | ± 0.1 | | ± 1.0 | μA |
| I _{CC} | Maximum Quiescent Supply Current | V _{in} = V _{CC} or GND | 5.5 | | | 2.0 | | 20.0 | μA |

AC ELECTRICAL CHARACTERISTICS (Input t_r = t_f = 3.0ns)

| Symbol | Parameter | Test Conditions | T _A = 25°C | | | T _A = -55°C to +125°C | | Unit |
|--|--|---|-----------------------|-------------|--------------|----------------------------------|--------------|------|
| | | | Min | Typ | Max | Min | Max | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, CP to Q or \bar{Q} | V _{CC} = 3.3 ± 0.3V C _L = 15pF C _L = 50pF | | 6.7 9.2 | 11.9 15.4 | 1.0 1.0 | 14.0 17.5 | ns |
| | | V _{CC} = 5.0 ± 0.5V C _L = 15pF C _L = 50pF | | 4.6 6.1 | 7.3 9.3 | 1.0 1.0 | 8.5 10.5 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, SD or RD to Q or \bar{Q} | V _{CC} = 3.3 ± 0.3V C _L = 15pF C _L = 50pF | | 7.6 10.1 | 12.3 15.8 | 1.0 1.0 | 14.5 18.0 | ns |
| | | V _{CC} = 5.0 ± 0.5V C _L = 15pF C _L = 50pF | | 4.8 6.3 | 7.7 9.7 | 1.0 1.0 | 9.0 11.0 | |
| f _{max} | Maximum Clock Frequency (50% Duty Cycle) | V _{CC} = 3.3 ± 0.3V C _L = 15pF C _L = 50pF | 80 50 | 125 75 | | 70 45 | | MHz |
| | | V _{CC} = 5.0 ± 0.5V C _L = 15pF C _L = 50pF | 130 90 | 170 115 | | 110 75 | | |
| C _{in} | Maximum Input Capacitance | | | 4 | 10 | | 10 | pF |

| C _{PD} | Power Dissipation Capacitance (Note 1) | Typical @ 25°C, V _{CC} = 5.0V | | pF |
|-----------------|--|--|--|----|
| | | 25 | | |
| | | | | |

1. C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I_{CC(OPR)} = C_{PD} • V_{CC} • f_{in} + I_{CC}/2 (per flip-flop). C_{PD} is used to determine the no-load dynamic power consumption; P_D = C_{PD} • V_{CC}² • f_{in} + I_{CC} • V_{CC}.

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TIMING REQUIREMENTS (Input $t_r = t_f = 3.0\text{ns}$)

| Symbol | Parameter | V _{CC} V | Guaranteed Limit | | Unit |
|------------------|---|------------------------|-----------------------|----------------------------------|------|
| | | | T _A = 25°C | T _A = -55°C to +125°C | |
| t _w | Minimum Pulse Width, CP | 3.3 ± 0.3 5.0 ± 0.5 | 6.0 5.0 | 7.0 5.0 | ns |
| t _w | Minimum Pulse Width, \overline{RD} or \overline{SD} | 3.3 ± 0.3 5.0 ± 0.5 | 6.0 5.0 | 7.0 5.0 | ns |
| t _{su} | Minimum Setup Time, D to CP | 3.3 ± 0.3 5.0 ± 0.5 | 6.0 5.0 | 7.0 5.0 | ns |
| t _h | Minimum Hold Time, D to CP | 3.3 ± 0.3 5.0 ± 0.5 | 0.5 0.5 | 0.5 0.5 | ns |
| t _{rec} | Minimum Recovery Time, \overline{SD} or \overline{RD} to CP | 3.3 ± 0.3 5.0 ± 0.5 | 5.0 3.0 | 5.0 3.0 | ns |

ORDERING INFORMATION

| Device | Package | Shipping† |
|----------------|------------------------|------------------|
| MC74VHC74DR2G | SOIC-14 (Pb-Free) | 2500 Tape & Reel |
| MC74VHC74DTG | TSSOP-14 | 96 Units / Rail |
| MC74VHC74DTR2G | TSSOP-14 | 2500 Tape & Reel |
| MC74VHC74MELG | SOEIAJ-14 (Pb-Free) | 2000 Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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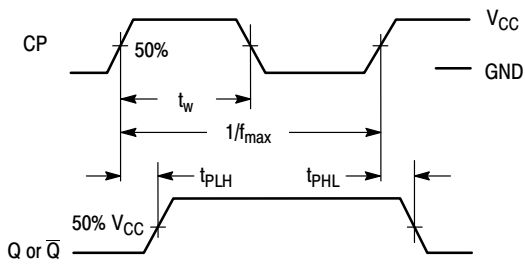


Figure 3.

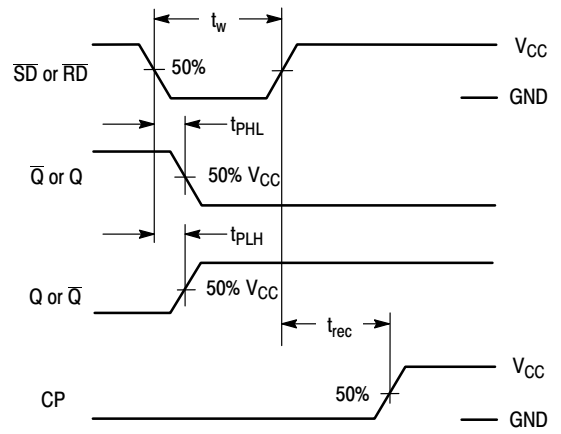


Figure 4.

Switching Waveforms

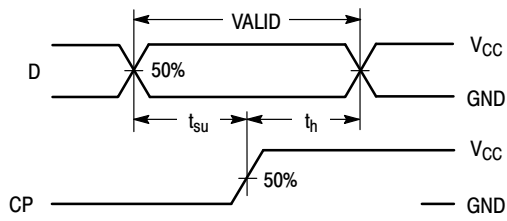
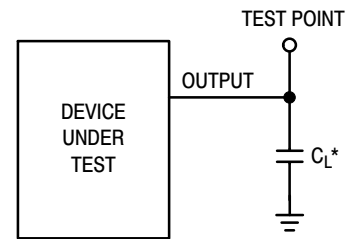


Figure 5.



*Includes all probe and jig capacitance

Figure 6.

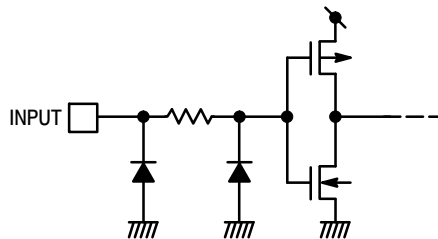
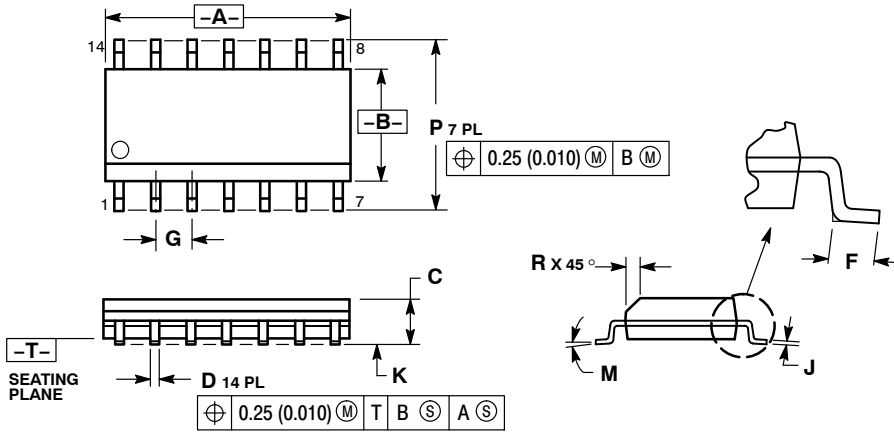


Figure 7. Input Equivalent Circuit

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PACKAGE DIMENSIONS

SOIC-14
CASE 751A-03
ISSUE J

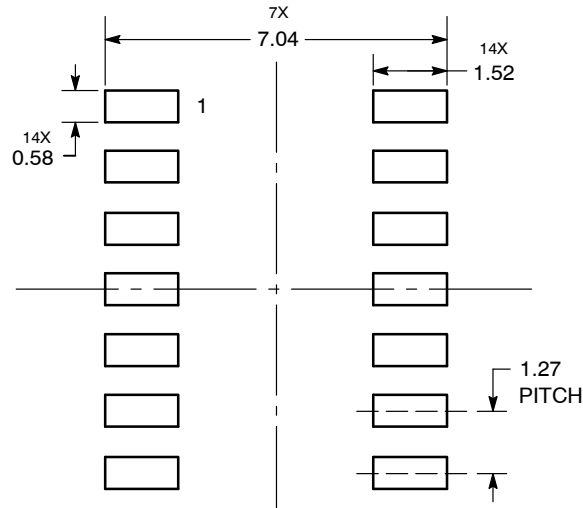


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 8.55 | 8.75 | 0.337 | 0.344 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | 7° | 0° | 7° |
| P | 5.80 | 6.20 | 0.228 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

SOLDERING FOOTPRINT*



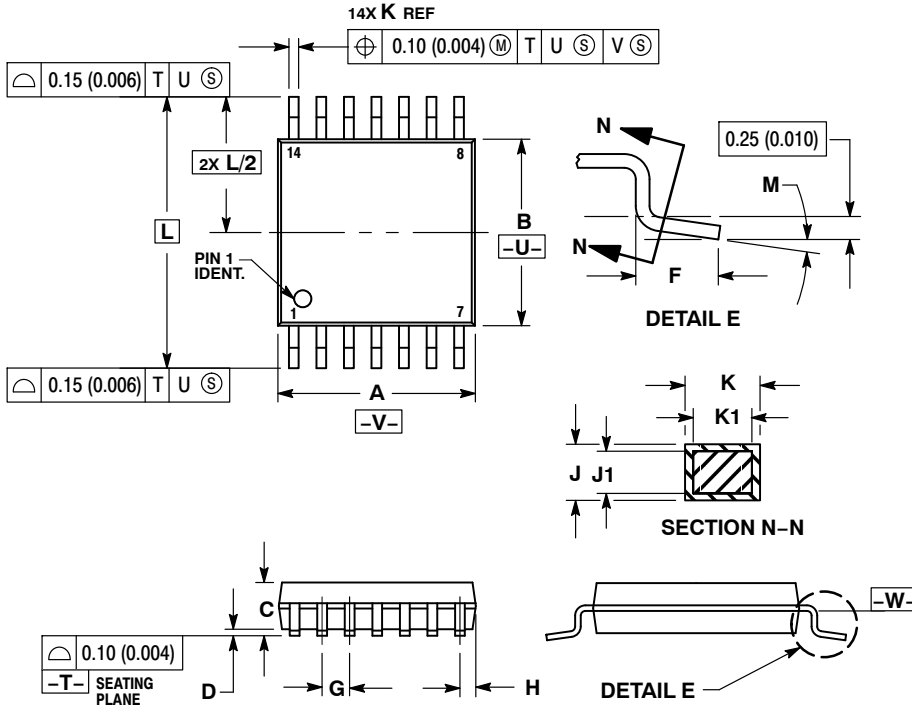
DIMENSIONS: MILLIMETERS

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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PACKAGE DIMENSIONS

TSSOP-14
DT SUFFIX
CASE 948G-01
ISSUE B

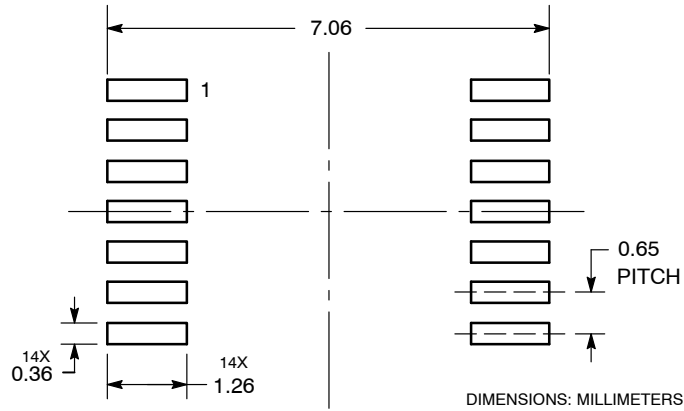


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.200 |
| B | 4.30 | 4.50 | 0.169 | 0.177 |
| C | --- | 1.20 | --- | 0.047 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.50 | 0.60 | 0.020 | 0.024 |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.19 | 0.30 | 0.007 | 0.012 |
| K1 | 0.19 | 0.25 | 0.007 | 0.010 |
| L | 6.40 BSC | | 0.252 BSC | |
| M | 0° | 8° | 0° | 8° |

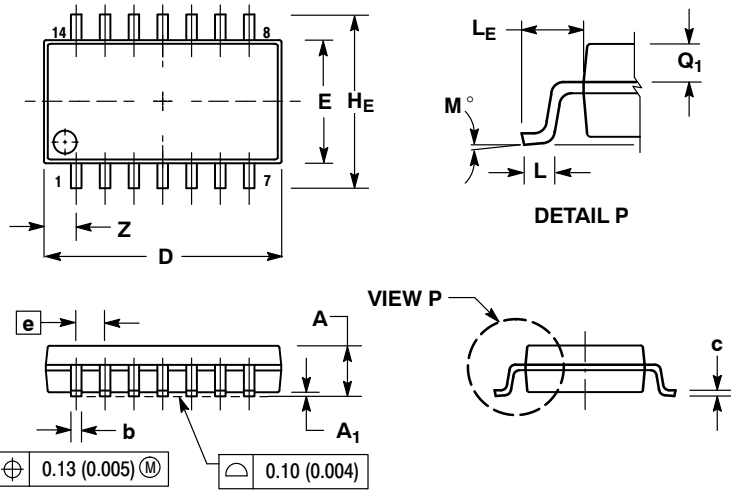
SOLDERING FOOTPRINT



MC74VHC74

PACKAGE DIMENSIONS

SOEIAJ-14
CASE 965-01
ISSUE B



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

| DIM | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | --- | 2.05 | --- | 0.081 |
| A ₁ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.10 | 0.20 | 0.004 | 0.008 |
| D | 9.90 | 10.50 | 0.390 | 0.413 |
| E | 5.10 | 5.45 | 0.201 | 0.215 |
| e | 1.27 BSC | | 0.050 BSC | |
| H _E | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| L _E | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0° | 10° | 0° | 10° |
| Q ₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 1.42 | --- | 0.056 |

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