

## 74VHC164

### 8-Bit Serial-In, Parallel-Out Shift Register

#### General Description

The VHC164 is an advanced high-speed CMOS device fabricated with silicon gate CMOS technology. It achieves the high-speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. The VHC164 is a high-speed 8-Bit Serial-In/Parallel-Out Shift Register. Serial data is entered through a 2-input AND gate synchronous with the LOW-to-HIGH transition of the clock. The device features an asynchronous Master Reset which clears the register, setting all outputs LOW independent of the clock. An input protection circuit insures that 0V to 7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery backup. This circuit prevents device destruction due to mismatched supply and input voltages.

#### Features

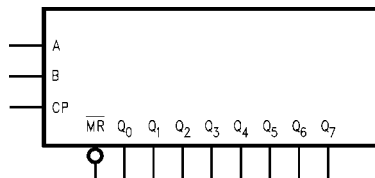
- High Speed:  $f_{MAX} = 175$  MHz at  $V_{CC} = 5V$
- Low power dissipation:  $I_{CC} = 4$   $\mu A$  (max) at  $T_A = 25^\circ C$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Power down protection provided on all inputs
- Low noise:  $V_{OLP} = 0.8V$  (max)
- Pin and function compatible with 74HC164

#### Ordering Code:

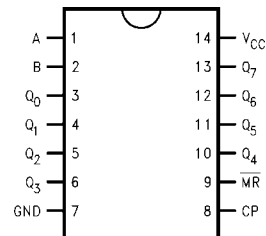
| Order Number | Package Number | Package Description                                                          |
|--------------|----------------|------------------------------------------------------------------------------|
| 74VHC164M    | M14A           | 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| 74VHC164SJ   | M14D           | 14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide                |
| 74VHC164MTC  | MTC14          | 14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  |
| 74VHC164N    | N14A           | 14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide       |

Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Logic Symbol



#### Connection Diagram



#### Pin Descriptions

| Pin Names       | Description                            |
|-----------------|----------------------------------------|
| A, B            | Data Inputs                            |
| CP              | Clock Pulse Input (Active Rising Edge) |
| $\overline{MR}$ | Master Reset Input (Active LOW)        |
| $Q_0$ - $Q_7$   | Outputs                                |

### Functional Description

The VHC164 is an edge-triggered 8-bit shift register with serial data entry and an output from each of the eight stages. Data is entered serially through one of two inputs (A or B); either of these inputs can be used as an active High Enable for data entry through the other input. An unused input must be tied HIGH.

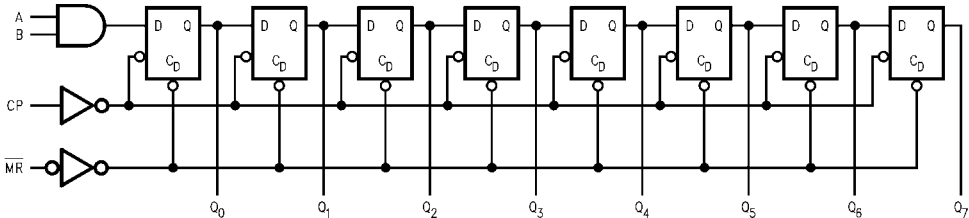
Each LOW-to-HIGH transition on the Clock (CP) input shifts data one place to the right and enters into Q<sub>0</sub> the logical AND of the two data inputs (A • B) that existed before the rising clock edge. A LOW level on the Master Reset ( $\overline{\text{MR}}$ ) input overrides all other inputs and clears the register asynchronously, forcing all Q outputs LOW.

### Function Table

| Operating Mode | Inputs                 |   |   | Outputs        |                                |
|----------------|------------------------|---|---|----------------|--------------------------------|
|                | $\overline{\text{MR}}$ | A | B | Q <sub>0</sub> | Q <sub>1</sub> -Q <sub>7</sub> |
| Reset (Clear)  | L                      | X | X | L              | L-L                            |
| Shift          | H                      | L | L | L              | Q <sub>0</sub> -Q <sub>6</sub> |
|                | H                      | L | H | L              | Q <sub>0</sub> -Q <sub>6</sub> |
|                | H                      | H | L | L              | Q <sub>0</sub> -Q <sub>6</sub> |
|                | H                      | H | H | H              | Q <sub>0</sub> -Q <sub>6</sub> |

H = HIGH Voltage Levels  
 L = LOW Voltage Levels  
 X = Immaterial  
 Q = Lower case letters indicate the state of the referenced input or output one setup time prior to the LOW-to-HIGH clock transition.

### Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Absolute Maximum Ratings**(Note 1)

|                                                       |                          |
|-------------------------------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )                           | -0.5V to +7.0V           |
| DC Input Voltage ( $V_{IN}$ )                         | -0.5V to +7.0V           |
| DC Output Voltage ( $V_{OUT}$ )                       | -0.5V to $V_{CC} + 0.5V$ |
| DC Diode Current ( $I_{IK}$ )                         | -20 mA                   |
| Output Diode Current ( $I_{OK}$ )                     | $\pm 20$ mA              |
| DC Output Current ( $I_{OUT}$ )                       | $\pm 25$ mA              |
| DC $V_{CC}$ /GND Current ( $I_{CC}$ )                 | $\pm 75$ mA              |
| Storage Temperature ( $T_{STG}$ )                     | -65°C to +150°C          |
| Lead Temperature ( $T_L$ )<br>(Soldering, 10 seconds) | 260°C                    |

**Recommended Operating Conditions** (Note 2)

|                                         |                   |
|-----------------------------------------|-------------------|
| Supply Voltage ( $V_{CC}$ )             | 2.0V to 5.5V      |
| Input Voltage ( $V_{IN}$ )              | 0V to +5.5V       |
| Output Voltage ( $V_{OUT}$ )            | 0V to $V_{CC}$    |
| Operating Temperature ( $T_{OPR}$ )     | -40°C to +85°C    |
| Input Rise and Fall Time ( $t_r, t_f$ ) |                   |
| $V_{CC} = 3.3V \pm 0.3V$                | 0 ns/V ~ 100 ns/V |
| $V_{CC} = 5.0V \pm 0.5V$                | 0 ns/V ~ 20 ns/V  |

**Note 1:** Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. Fairchild does not recommend operation of circuits outside databook specifications.

**Note 2:** Unused inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

| Symbol   | Parameter                 | $V_{CC}$<br>(V)  | $T_A = 25^\circ\text{C}$ |     |                      | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ |                      | Units         | Conditions                                                     |
|----------|---------------------------|------------------|--------------------------|-----|----------------------|-------------------------------------------------|----------------------|---------------|----------------------------------------------------------------|
|          |                           |                  | Min                      | Typ | Max                  | Min                                             | Max                  |               |                                                                |
| $V_{IH}$ | HIGH Level Input Voltage  | 2.0<br>3.0– 5.5  | 1.50<br>0.7 $V_{CC}$     |     |                      | 1.50<br>0.7 $V_{CC}$                            |                      | V             |                                                                |
| $V_{IL}$ | LOW Level Input Voltage   | 2.0<br>3.0 – 5.5 |                          |     | 0.50<br>0.3 $V_{CC}$ |                                                 | 0.50<br>0.3 $V_{CC}$ | V             |                                                                |
| $V_{OH}$ | HIGH Level Output Voltage | 2.0              | 1.9                      | 2.0 |                      | 1.9                                             |                      | V             | $V_{IN} = V_{IH}$<br>or $V_{IL}$<br>$I_{OH} = -50 \mu\text{A}$ |
|          |                           | 3.0              | 2.9                      | 3.0 |                      | 2.9                                             |                      |               |                                                                |
|          |                           | 4.5              | 4.4                      | 4.5 |                      | 4.4                                             |                      | V             | $I_{OH} = -4 \text{ mA}$<br>$I_{OH} = -8 \text{ mA}$           |
|          |                           | 3.0<br>4.5       | 2.58<br>3.94             |     |                      | 2.48<br>3.80                                    |                      |               |                                                                |
| $V_{OL}$ | LOW Level Output Voltage  | 2.0              |                          | 0.0 | 0.1                  |                                                 | 0.1                  | V             | $V_{IN} = V_{IH}$<br>or $V_{IL}$<br>$I_{OL} = 50 \mu\text{A}$  |
|          |                           | 3.0              |                          | 0.0 | 0.1                  |                                                 | 0.1                  |               |                                                                |
|          |                           | 4.5              |                          | 0.0 | 0.1                  |                                                 | 0.1                  | V             | $I_{OL} = 4 \text{ mA}$<br>$I_{OL} = 8 \text{ mA}$             |
|          |                           | 3.0<br>4.5       |                          |     | 0.36<br>0.36         |                                                 | 0.44<br>0.44         |               |                                                                |
| $I_{IN}$ | Input Leakage Current     | 0 – 5.5          |                          |     | $\pm 0.1$            |                                                 | $\pm 1.0$            | $\mu\text{A}$ | $V_{IN} = 5.5V$ or GND                                         |
| $I_{CC}$ | Quiescent Supply Current  | 5.5              |                          |     | 4.0                  |                                                 | 40.0                 | $\mu\text{A}$ | $V_{IN} = V_{CC}$ or GND                                       |

**Noise Characteristics**

| Symbol                | Parameter                                   | $V_{CC}$<br>(V) | $T_A = 25^\circ\text{C}$ |        | Units | Conditions            |
|-----------------------|---------------------------------------------|-----------------|--------------------------|--------|-------|-----------------------|
|                       |                                             |                 | Typ                      | Limits |       |                       |
| $V_{OLP}$<br>(Note 3) | Quiet Output Maximum<br>Dynamic $V_{OL}$    | 5.0             | 0.5                      | 0.8    | V     | $C_L = 50 \text{ pF}$ |
| $V_{OLV}$<br>(Note 3) | Quiet Output Minimum<br>Dynamic $V_{OL}$    | 5.0             | -0.5                     | 0.8    | V     | $C_L = 50 \text{ pF}$ |
| $V_{IHD}$<br>(Note 3) | Minimum HIGH Level<br>Dynamic Input Voltage | 5.0             |                          | 3.5    | V     | $C_L = 50 \text{ pF}$ |
| $V_{ILD}$<br>(Note 3) | Maximum LOW Level<br>Dynamic Input Voltage  | 5.0             |                          | 1.5    | V     | $C_L = 50 \text{ pF}$ |

**Note 3:** Parameter guaranteed by design.

## AC Electrical Characteristics

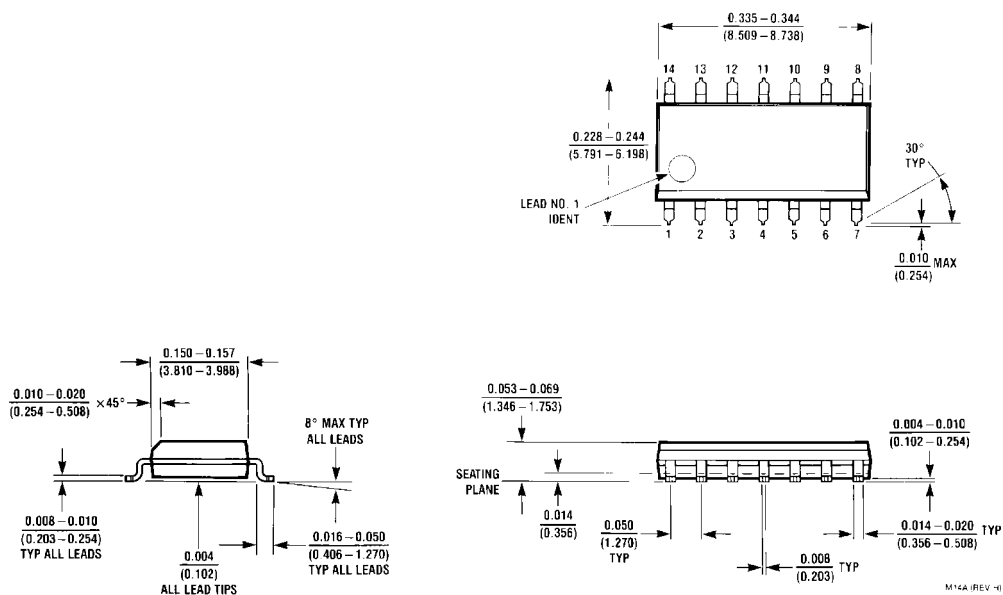
| Symbol           | Parameter                                      | V <sub>CC</sub><br>(V) | T <sub>A</sub> = 25°C |      |      | T <sub>A</sub> = -40°C to +85°C |      | Units | Conditions                                  |
|------------------|------------------------------------------------|------------------------|-----------------------|------|------|---------------------------------|------|-------|---------------------------------------------|
|                  |                                                |                        | Min                   | Typ  | Max  | Min                             | Max  |       |                                             |
| f <sub>MAX</sub> | Maximum Clock Frequency                        | 3.3 ± 0.3              | 80                    | 125  |      | 65                              |      | MHz   | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1k |
|                  |                                                |                        | 50                    | 75   |      | 45                              |      |       | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1k |
|                  |                                                | 5.0 ± 0.5              | 125                   | 175  |      | 105                             |      | MHz   | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1k |
|                  |                                                |                        | 85                    | 115  |      | 75                              |      |       | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1k |
| t <sub>PLH</sub> | Propagation Delay<br>Time (CP-Q <sub>n</sub> ) | 3.3 ± 0.3              |                       | 8.4  | 12.8 | 1.0                             | 15.0 | ns    | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1k |
| t <sub>PHL</sub> |                                                |                        |                       | 10.9 | 16.3 | 1.0                             | 18.5 |       | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1k |
|                  |                                                | 5.0 ± 0.5              |                       | 5.8  | 9.0  | 1.0                             | 10.5 | ns    | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1k |
|                  |                                                |                        |                       | 7.3  | 11.0 | 1.0                             | 12.5 |       | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1k |
| t <sub>PHL</sub> | Propagation Delay<br>Time (MR-Q <sub>n</sub> ) | 3.3 ± 0.3              |                       | 8.3  | 12.8 | 1.0                             | 15.0 | ns    | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1k |
|                  |                                                |                        |                       | 10.8 | 16.3 | 1.0                             | 18.5 |       | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1k |
|                  |                                                | 5.0 ± 0.5              |                       | 5.2  | 8.6  | 1.0                             | 10.0 | ns    | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1k |
|                  |                                                |                        |                       | 6.7  | 10.6 | 1.0                             | 12.0 |       | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1k |
| C <sub>IN</sub>  | Input Capacitance                              |                        |                       | 4    | 10   |                                 | 10   | pF    | V <sub>CC</sub> = Open                      |
| C <sub>PD</sub>  | Power Dissipation<br>Capacitance               |                        |                       | 76   |      |                                 |      | pF    | (Note 4)                                    |

**Note 4:** C<sub>PD</sub> 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 from the equation: I<sub>CC</sub> (opr.) = C<sub>PD</sub> \* V<sub>CC</sub> \* f<sub>IN</sub> + I<sub>CC</sub>.

## AC Operating Requirements

| Symbol             | Parameter                                       | V <sub>CC</sub><br>(V)<br>(Note 5) | T <sub>A</sub> = 25°C |                    | T <sub>A</sub> = -40°C to +85°C | Units |
|--------------------|-------------------------------------------------|------------------------------------|-----------------------|--------------------|---------------------------------|-------|
|                    |                                                 |                                    | Typ                   | Guaranteed Minimum |                                 |       |
| t <sub>W</sub> (L) | Minimum Pulse Width (CP)                        | 3.3                                |                       | 5.0                | 5.0                             | ns    |
| t <sub>W</sub> (H) |                                                 | 5.0                                |                       | 5.0                | 5.0                             |       |
| t <sub>W</sub> (L) | Minimum Pulse Width ( $\overline{\text{MR}}$ )  | 3.3                                |                       | 5.0                | 5.0                             | ns    |
|                    |                                                 | 5.0                                |                       | 5.0                | 5.0                             |       |
| t <sub>S</sub>     | Minimum Setup Time                              | 3.3                                |                       | 5.0                | 6.0                             | ns    |
|                    |                                                 | 5.0                                |                       | 4.5                | 4.5                             |       |
| t <sub>H</sub>     | Minimum Hold Time                               | 3.3                                |                       | 0.0                | 0.0                             | ns    |
|                    |                                                 | 5.0                                |                       | 1.0                | 1.0                             |       |
| t <sub>REC</sub>   | Minimum Removal Time ( $\overline{\text{MR}}$ ) | 3.3                                |                       | 2.5                | 2.5                             | ns    |
|                    |                                                 | 5.0                                |                       | 2.5                | 2.5                             |       |

**Note 5:** V<sub>CC</sub> is 3.3 ± 0.3V or 5.0 ± 0.5V

**Physical Dimensions** inches (millimeters) unless otherwise noted


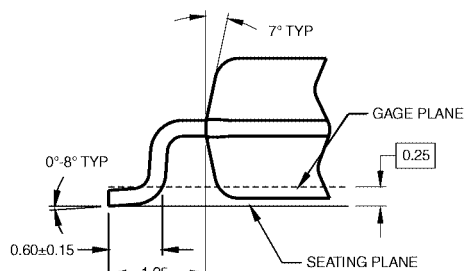
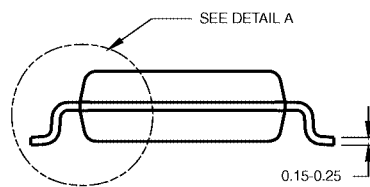
**14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow  
Package Number M14A**



### LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS



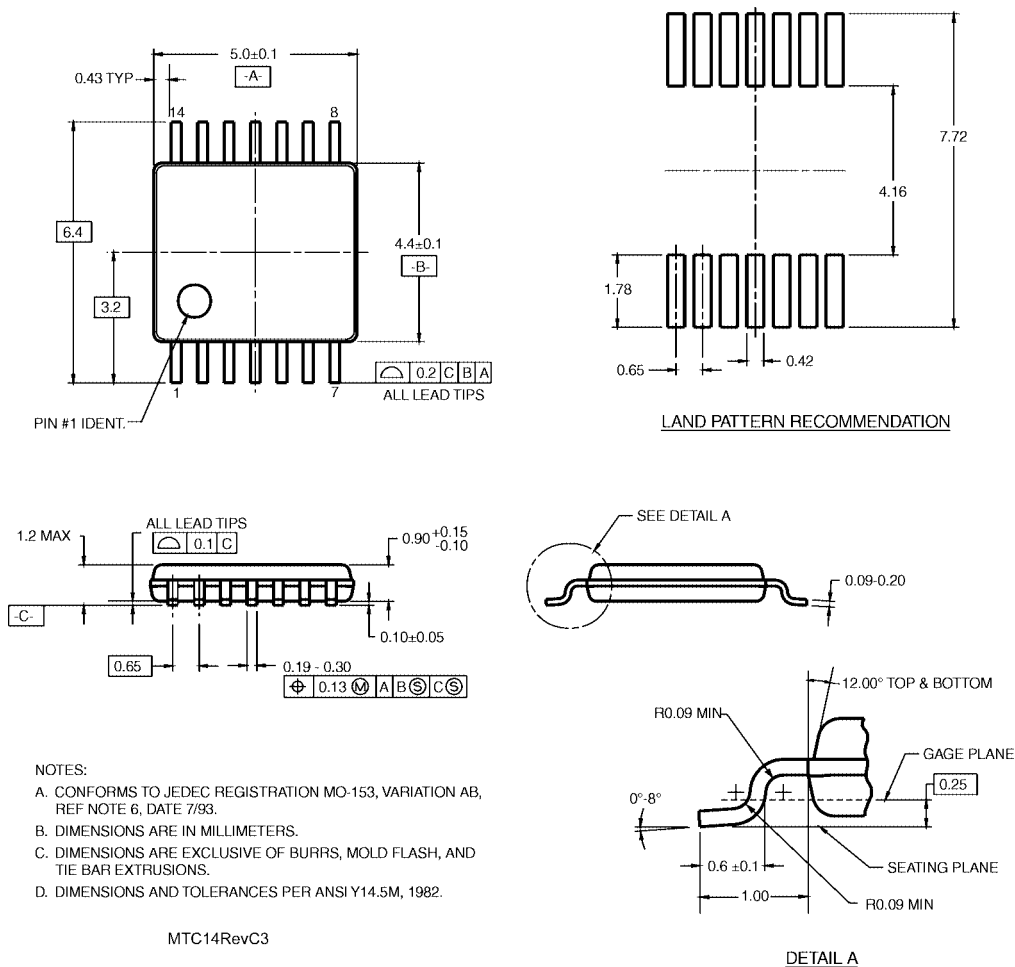
DETAIL A

NOTES:

- A. CONFORMS TO EIAJ EDR-7320 REGISTRATION,  
ESTABLISHED IN DECEMBER, 1998.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD  
FLASH, AND TIE BAR EXTRUSIONS.

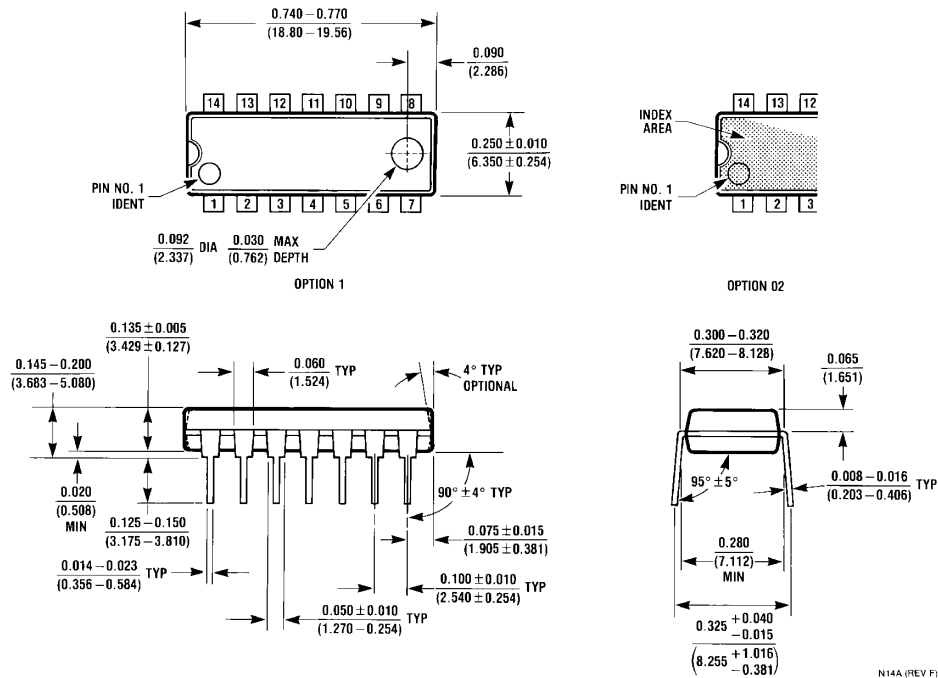
M14DRevB1

**14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide  
Package Number M14D**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)


**14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  
Package Number MTC14**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide  
Package Number N14A

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