FAIRCHILD SEMICONDUCTOR™

October 1987
Revised March 2002

# CD4047BC
# Low Power Monostable/Astable Multivibrator

## General Description

The CD4047B is capable of operating in either the monostable or astable mode. It requires an external capacitor (between pins 1 and 3) and an external resistor (between pins 2 and 3) to determine the output pulse width in the monostable mode, and the output frequency in the astable mode.

Astable operation is enabled by a high level on the astable input or low level on the astable input. The output frequency (at 50% duty cycle) at Q and $\overline{Q}$ outputs is determined by the timing components. A frequency twice that of Q is available at the Oscillator Output; a 50% duty cycle is not guaranteed.

Monostable operation is obtained when the device is triggered by LOW-to-HIGH transition at + trigger input or HIGH-to-LOW transition at – trigger input. The device can be retriggered by applying a simultaneous LOW-to-HIGH transition to both the + trigger and retrigger inputs.

A high level on Reset input resets the outputs Q to LOW, $\overline{Q}$ to HIGH.

## Features

- Wide supply voltage range: 3.0V to 15V
- High noise immunity: 0.45 $V_{DD}$ (typ.)
- Low power TTL compatibility: Fan out of 2 driving 74L or 1 driving 74LS

## Special Features

- Low power consumption: special CMOS oscillator configuration
- Monostable (one-shot) or astable (free-running) operation
- True and complemented buffered outputs
- Only one external R and C required

## Monostable Multivibrator Features

- Positive- or negative-edge trigger
- Output pulse width independent of trigger pulse duration
- Retriggerable option for pulse width expansion
- Long pulse widths possible using small RC components by means of external counter provision
- Fast recovery time essentially independent of pulse width
- Pulse-width accuracy maintained at duty cycles approaching 100%

## Astable Multivibrator Features

- Free-running or gatable operating modes
- 50% duty cycle
- Oscillator output available
- Good astable frequency stability

  typical= ±2% + 0.03%/°C @ 100 kHz

  frequency= ±0.5% + 0.015%/°C @ 10 kHz

  deviation (circuits trimmed to frequency $V_{DD}$ = 10V ±10%)

## Applications

- Frequency discriminators
- Timing circuits
- Time-delay applications
- Envelope detection
- Frequency multiplication
- Frequency division

## Ordering Code:

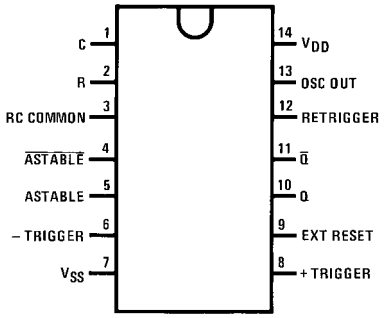
| Order Number | Package Number | Package Description |
|---|---|---|
| CD4047BCM | M14A | 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| CD4047BCN | N14A | 14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

## Connection Diagram

**Pin Assignments for SOIC and DIP**



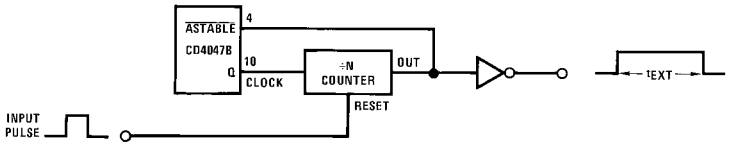

**Top View**

## Function Table

| Function | Terminal Connections | | | Output Pulse From | Typical Output Period or Pulse Width |
|---|---|---|---|---|---|
| | To $V_{DD}$ | To $V_{SS}$ | Input Pulse To | | |
| Astable Multivibrator | | | | | |
| Free-Running | 4, 5, 6, 14 | 7, 8, 9, 12 | | 10, 11, 13 | $t_A(10, 11) = 4.40$ RC |
| True Gating | 4, 6, 14 | 7, 8, 9, 12 | 5 | 10, 11, 13 | $t_A(13) = 2.20$ RC |
| Complement Gating | 6, 14 | 5, 7, 8, 9, 12 | 4 | 10, 11, 13 | |
| Monostable Multivibrator | | | | | |
| Positive-Edge Trigger | 4, 14 | 5, 6, 7, 9, 12 | 8 | 10, 11 | |
| Negative-Edge Trigger | 4, 8, 14 | 5, 7, 9, 12 | 6 | 10, 11 | $t_M(10, 11) = 2.48$ RC |
| Retriggerable | 4, 14 | 5, 6, 7, 9 | 8, 12 | 10, 11 | |
| External Countdown (Note 1) | 14 | 5, 6, 7, 8, 9, 12 | Figure 1 | Figure 1 | Figure 1 |

**Note 1:** External resistor between terminals 2 and 3. External capacitor between terminals 1 and 3.

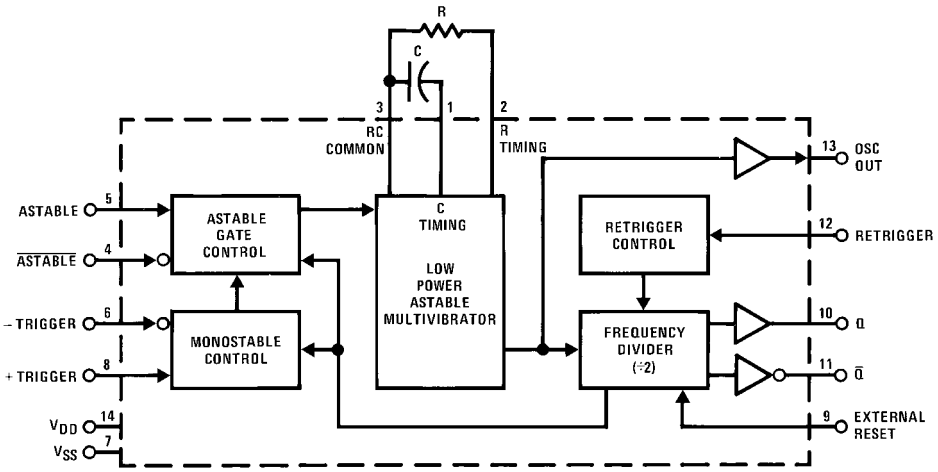
## Typical Implementation of External Countdown Option



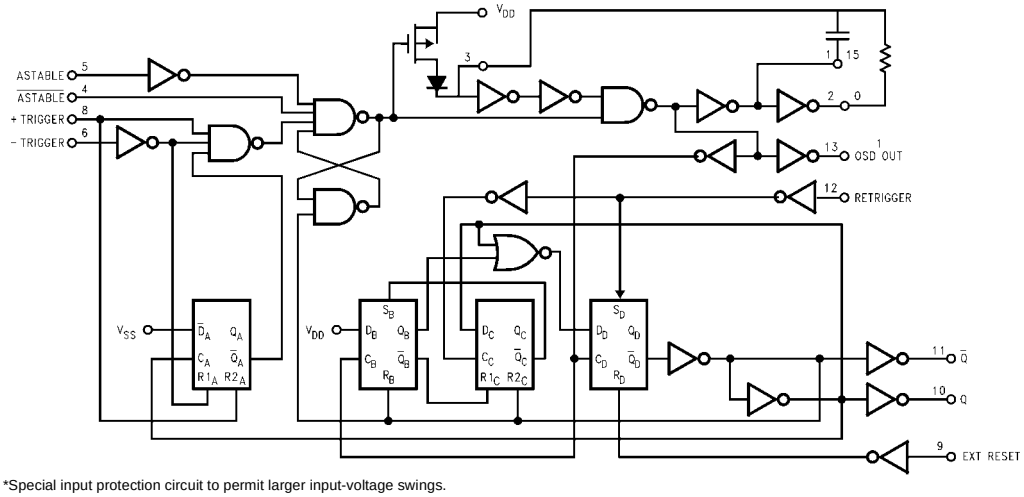

$t_{EXT} = (N - 1)\, t_A + (t_M + t_A/2)$

**FIGURE 1.**

## Block Diagram




## Logic Diagram




*Special input protection circuit to permit larger input-voltage swings.

## Absolute Maximum Ratings(Note 2)

(Note 3)

| | |
|---|---|
| DC Supply Voltage ($V_{DD}$) | −0.5V to +18$V_{DC}$ |
| Input Voltage ($V_{IN}$) | −0.5V to $V_{DD}$ +0.5$V_{DC}$ |
| Storage Temperature Range ($T_S$) | −65°C to +150°C |
| Power Dissipation ($P_D$) | |
| Dual-In-Line | 700 mW |
| Small Outline | 500 mW |
| Lead Temperature ($T_L$) | |
| (Soldering, 10 seconds) | 260°C |

## Recommended Operating Conditions (Note 3)

| | |
|---|---|
| DC Supply Voltage ($V_{DD}$) | 3V to 15$V_{DC}$ |
| Input Voltage ($V_{IN}$) | 0 to $V_{DD}$ $V_{DC}$ |
| Operating Temperature Range ($T_A$) | −55°C to +125°C |

**Note 2:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

**Note 3:** $V_{SS}$ = 0V unless otherwise specified.

## DC Electrical Characteristics (Note 3)

| Symbol | Parameter | Conditions | −55°C | | 25°C | | | 125°C | | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| $I_{DD}$ | Quiescent Device Current | $V_{DD}$ = 5V | | 5 | | | 5 | | 150 | |
| | | $V_{DD}$ = 10V | | 10 | | | 10 | | 300 | µA |
| | | $V_{DD}$ = 15V | | 20 | | | 20 | | 600 | |
| $V_{OL}$ | LOW Level Output Voltage | $\|I_O\|$ < 1 µA | | | | | | | | |
| | | $V_{DD}$ = 5V | | 0.05 | | 0 | 0.05 | | 0.05 | |
| | | $V_{DD}$ = 10V | | 0.05 | | 0 | 0.05 | | 0.05 | V |
| | | $V_{DD}$ = 15V | | 0.05 | | 0 | 0.05 | | 0.05 | |
| $V_{OH}$ | HIGH Level Output Voltage | $\|I_O\|$ < 1 µA | | | | | | | | |
| | | $V_{DD}$ = 5V | 4.95 | | 4.95 | 5 | | 4.95 | | |
| | | $V_{DD}$ = 10V | 9.95 | | 9.95 | 10 | | 9.95 | | V |
| | | $V_{DD}$ = 15V | 14.95 | | 14.95 | 15 | | 14.95 | | |
| $V_{IL}$ | LOW Level Input Voltage | $V_{DD}$ = 5V, $V_O$ = 0.5V or 4.5V | | 1.5 | | 2.25 | 1.5 | | 1.5 | |
| | | $V_{DD}$ = 10V, $V_O$ = 1V or 9V | | 3.0 | | 4.5 | 3.0 | | 3.0 | V |
| | | $V_{DD}$ = 15V, $V_O$ = 1.5V or 13.5V | | 4.0 | | 6.75 | 4.0 | | 4.0 | |
| $V_{IH}$ | HIGH Level Input Voltage | $V_{DD}$ = 5V, $V_O$ = 0.5V or 4.5V | 3.5 | | 3.5 | 2.75 | | 3.5 | | |
| | | $V_{DD}$ = 10V, $V_O$ = 1V or 9V | 7.0 | | 7.0 | 5.5 | | 7.0 | | V |
| | | $V_{DD}$ = 15V, $V_O$ = 1.5V or 13.5V | 11.0 | | 11.0 | 8.25 | | 11.0 | | |
| $I_{OL}$ | LOW Level Output Current | $V_{DD}$ = 5V, $V_O$ = 0.4V | 0.64 | | 0.51 | 0.88 | | 0.36 | | |
| | (Note 4) | $V_{DD}$ = 10V, $V_O$ = 0.5V | 1.6 | | 1.3 | 2.25 | | 0.9 | | mA |
| | | $V_{DD}$ = 15V, $V_O$ = 1.5V | 4.2 | | 3.4 | 8.8 | | 2.4 | | |
| $I_{OH}$ | HIGH Level Output Current | $V_{DD}$ = 5V, $V_O$ = 4.6V | −0.64 | | −0.51 | −0.88 | | −0.36 | | |
| | (Note 4) | $V_{DD}$ = 10V, $V_O$ = 9.5V | −1.6 | | −1.3 | −2.25 | | −0.9 | | mA |
| | | $V_{DD}$ = 15V, $V_O$ = 13.5V | −4.2 | | −3.4 | −8.8 | | −2.4 | | |
| $I_{IN}$ | Input Current | $V_{DD}$ = 15V, $V_{IN}$ = 0V | | −0.1 | | $-10^{-5}$ | −0.1 | | −1.0 | µA |
| | | $V_{DD}$ = 15V, $V_{IN}$ = 15V | | 0.1 | | $10^{-5}$ | 0.1 | | 1.0 | |

**Note 4:** $I_{OH}$ and $I_{OL}$ are tested one output at a time.

## AC Electrical Characteristics (Note 5)

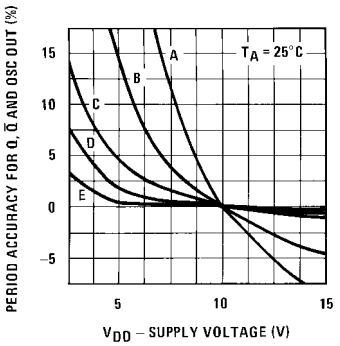
$T_A = 25°C$, $C_L = 50$ pF, $R_L = 200$k, input $t_r = t_f = 20$ ns, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_{PHL}$, $t_{PLH}$ | Propagation Delay Time Astable, | $V_{DD} = 5V$ | | 200 | 400 | |
| | $\overline{\text{Astable}}$ to Osc Out | $V_{DD} = 10V$ | | 100 | 200 | ns |
| | | $V_{DD} = 15V$ | | 80 | 160 | |
| $t_{PHL}$, $t_{PLH}$ | Astable, $\overline{\text{Astable}}$ to Q, $\overline{Q}$ | $V_{DD} = 5V$ | | 550 | 900 | |
| | | $V_{DD} = 10V$ | | 250 | 500 | ns |
| | | $V_{DD} = 15V$ | | 200 | 400 | |
| $t_{PHL}$, $t_{PLH}$ | + Trigger, − Trigger to $\overline{Q}$ | $V_{DD} = 5V$ | | 700 | 1200 | |
| | | $V_{DD} = 10V$ | | 300 | 600 | ns |
| | | $V_{DD} = 15V$ | | 240 | 480 | |
| $t_{PHL}$, $t_{PLH}$ | + Trigger, Retrigger to $\overline{Q}$ | $V_{DD} = 5V$ | | 300 | 600 | |
| | | $V_{DD} = 10V$ | | 175 | 300 | ns |
| | | $V_{DD} = 15V$ | | 150 | 250 | |
| $t_{PHL}$, $t_{PLH}$ | Reset to Q, $\overline{Q}$ | $V_{DD} = 5V$ | | 300 | 600 | |
| | | $V_{DD} = 10V$ | | 125 | 250 | ns |
| | | $V_{DD} = 15V$ | | 100 | 200 | |
| $t_{THL}$, $t_{TLH}$ | Transition Time Q, $\overline{Q}$, Osc Out | $V_{DD} = 5V$ | | 100 | 200 | |
| | | $V_{DD} = 10V$ | | 50 | 100 | ns |
| | | $V_{DD} = 15V$ | | 40 | 80 | |
| $t_{WL}$, $t_{WH}$ | Minimum Input Pulse Duration | Any Input | | | | |
| | | $V_{DD} = 5V$ | | 500 | 1000 | |
| | | $V_{DD} = 10V$ | | 200 | 400 | ns |
| | | $V_{DD} = 15V$ | | 160 | 320 | |
| $t_{RCL}$, $t_{FCL}$ | + Trigger, Retrigger, Rise and | $V_{DD} = 5V$ | | | 15 | |
| | Fall Time | $V_{DD} = 10V$ | | | 5 | µs |
| | | $V_{DD} = 15V$ | | | 5 | |
| $C_{IN}$ | Average Input Capacitance | Any Input | | 5 | 7.5 | pF |

**Note 5:** AC Parameters are guaranteed by DC correlated testing.

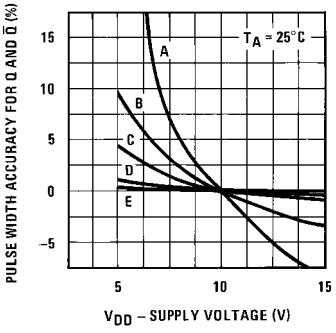
## Typical Performance Characteristics

**Typical Q, $\overline{Q}$, Osc Out Period Accuracy vs Supply Voltage (Astable Mode Operation)**



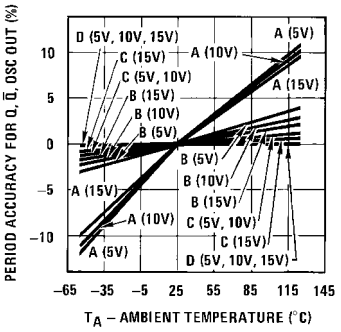

| | $f_Q, \overline{Q}$ | R | C |
|---|---|---|---|
| **A** | 1000 kHz | 22k | 10 pF |
| **B** | 100 kHz | 22k | 100 pF |
| **C** | 10 kHz | 220k | 100 pF |
| **D** | 1 kHz | 220k | 1000 pF |
| **E** | 100 Hz | 2.2M | 1000 pF |

**Typical Q, $\overline{Q}$, Pulse Width Accuracy vs Supply Voltage Monostable Mode Operation**



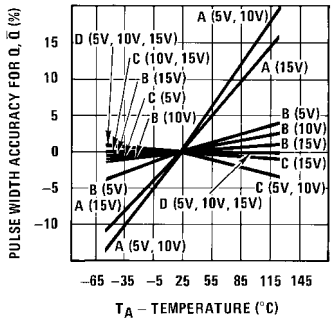

| | $t_M$ | R | C |
|---|---|---|---|
| **A** | 2 µs | 22k | 10 pF |
| **B** | 7 µs | 22k | 100 pF |
| **C** | 60 µs | 220k | 100 pF |
| **D** | 550 µs | 220k | 1000 pF |
| **E** | 5.5 ms | 2.2M | 1000 pF |

**Typical Q, $\overline{Q}$ and Osc Out Period Accuracy vs Temperature Astable Mode Operation**




| | $f_Q, \overline{Q}$ | R | C |
|---|---|---|---|
| **A** | 1000 kHz | 22k | 10 pF |
| **B** | 100 kHz | 22k | 100 pF |
| **C** | 10 kHz | 220k | 100 pF |
| **D** | 1 kHz | 220k | 1000 pF |

**Typical Q and $\overline{Q}$ Pulse Width Accuracy vs Temperature Monostable Mode Operation**



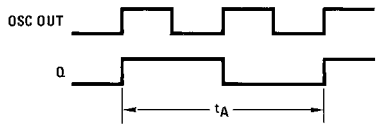

| | $t_M$ | R | C |
|---|---|---|---|
| **A** | 2 µs | 22k | 10 pF |
| **B** | 7 µs | 22k | 100 pF |
| **C** | 60 µs | 220k | 100 pF |
| **D** | 550 µs | 220k | 1000 pF |

**Note:** Minimum Value of R: 10 K Ω
Maximum Value of R: 1 Meg Ω
Minimum Value of C for Astable Mode: 100 pF
Minimum Value of C for Monostable Mode: 1000 pF

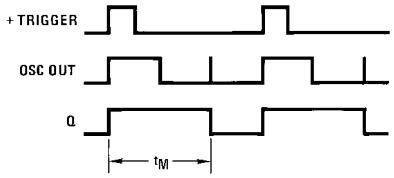
## Typical Performance Characteristics (Continued)

### Timing Diagrams

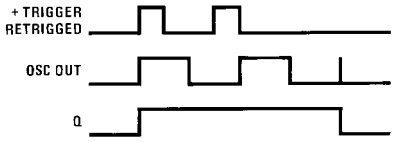
**Astable Mode**



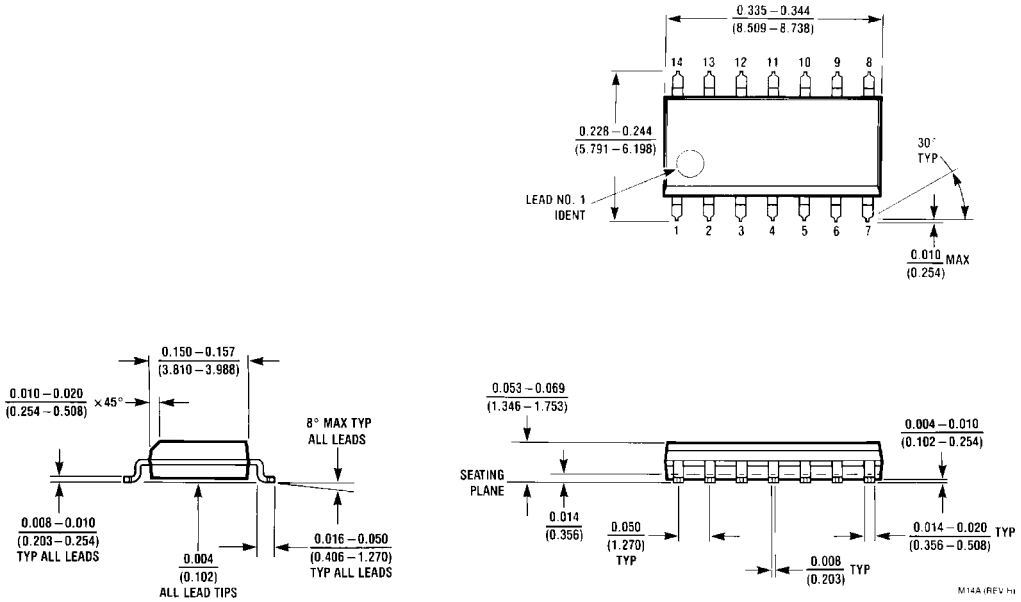

**Monostable Mode**




**Retrigger Mode**

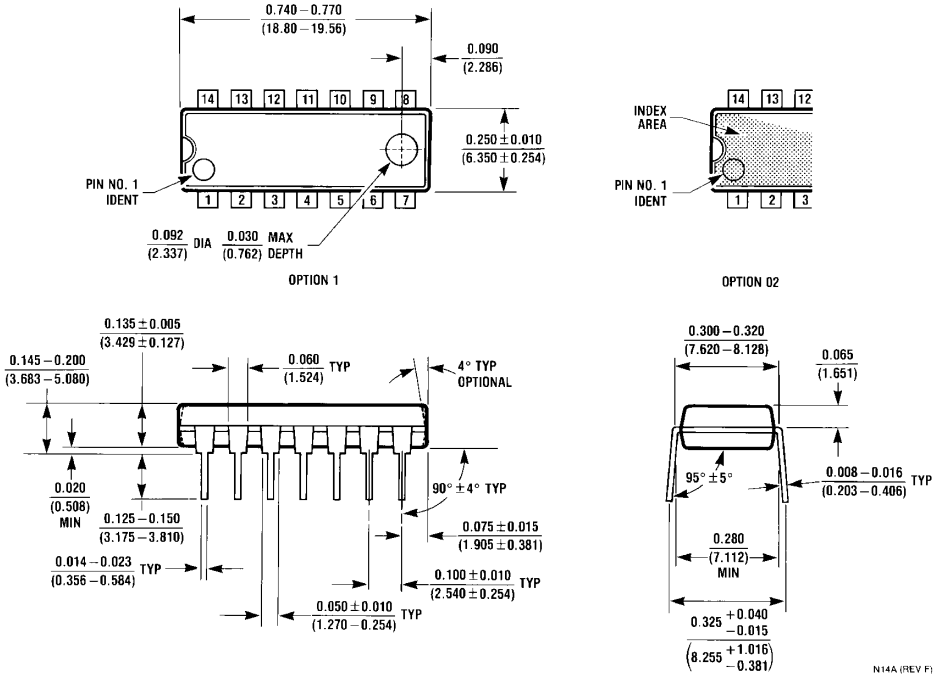


## Physical Dimensions inches (millimeters) unless otherwise noted




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

## 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**



**LIFE SUPPORT POLICY**

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

**www.fairchildsemi.com**