FAIRCHILD SEMICONDUCTOR™

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# CD4511BC
# BCD-to-7 Segment Latch/Decoder/Driver

## General Description

The CD4511BC BCD-to-seven segment latch/decoder/driver is constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and an output drive capability. Lamp test (LT), blanking (BI), and latch enable (LE) inputs are used to test the display, to turn-off or pulse modulate the brightness of the display, and to store a BCD code, respectively. It can be used with seven-segment light emitting diodes (LED), incandescent, fluorescent, gas discharge, or liquid crystal readouts either directly or indirectly.

Applications include instrument (e.g., counter, DVM, etc.) display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

## Features

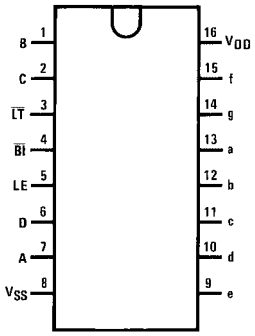
- Low logic circuit power dissipation
- High current sourcing outputs (up to 25 mA)
- Latch storage of code
- Blanking input
- Lamp test provision
- Readout blanking on all illegal input combinations
- Lamp intensity modulation capability
- Time share (multiplexing) facility
- Equivalent to Motorola MC14511

## Ordering Code:

| Order Number | Package Number | Package Description |
|---|---|---|
| CD4511BCWM | M16B | 16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| CD4511BCN | N16E | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide |

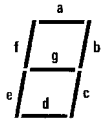
Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

## Connection Diagrams




**Top View**

**Segment Identification**

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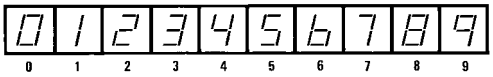
## Truth Table

| Inputs | | | | | | | Outputs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LE | $\overline{BI}$ | $\overline{LT}$ | D | C | B | A | a | b | c | d | e | f | g | Display |
| X | X | 0 | X | X | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 1 | B |
| X | 0 | 1 | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 3 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 5 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 6 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 7 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 9 |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1 | 1 | 1 | X | X | X | X | | | | * | | | | * |

X = Don't Care

*Depends upon the BCD code applied during the 0 to 1 transition of LE.

## Display



## Absolute Maximum Ratings(Note 1)

| | |
|---|---|
| DC Supply Voltage ($V_{DD}$) | −0.5V to +18V |
| Input Voltage ($V_{IN}$) | −0.5V to $V_{DD}$ +0.5V |
| 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

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

**Note 1:** Devices should not be connected with power on.

## DC Electrical Characteristics

| Symbol | Parameter | Conditions | −55°C | | +25°C | | | +125°C | | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| $I_{DD}$ | Quiescent | $V_{DD}$ = 5V | | 5 | | | 5 | | 150 | |
| | Supply Current | $V_{DD}$ = 10V | | 10 | | | 10 | | 300 | µA |
| | | $V_{DD}$ = 15V | | 20 | | | 20 | | 600 | |
| $V_{OL}$ | Output Voltage | $V_{DD}$ = 5V | | 0.01 | | 0 | 0.01 | | 0.05 | |
| | Logical “0” | $V_{DD}$ = 10V | | 0.01 | | 0 | 0.01 | | 0.05 | V |
| | Level | $V_{DD}$ = 15V | | 0.01 | | 0 | 0.01 | | 0.05 | |
| $V_{OH}$ | Output Voltage | $V_{DD}$ = 5V | 4.1 | | 4.1 | 4.57 | | 4.1 | | |
| | Logical “1” | $V_{DD}$ = 10V | 9.1 | | 9.1 | 9.58 | | 9.1 | | V |
| | Level | $V_{DD}$ = 15V | 14.1 | | 14.1 | 14.59 | | 14.1 | | |
| $V_{IL}$ | LOW Level | $V_{DD}$ = 5V, $V_{OUT}$ = 3.8V or 0.5V | | 1.5 | | 2 | 1.5 | | 1.5 | |
| | Input Voltage | $V_{DD}$ = 10V, $V_{OUT}$ = 8.8V or 1.0V | | 3.0 | | 4 | 3.0 | | 3.0 | V |
| | | $V_{DD}$ = 15V, $V_{OUT}$ = 13.8V or 1.5V | | 4.0 | | 6 | 4.0 | | 4.0 | |
| $V_{IH}$ | HIGH Level | $V_{DD}$ = 5V, $V_{OUT}$ = 0.5V or 3.8V | 3.5 | | 3.5 | 3 | | 3.5 | | |
| | Input Voltage | $V_{DD}$ = 10V, $V_{OUT}$ = 1.0V or 8.8V | 7.0 | | 7.0 | 6 | | 7.0 | | V |
| | | $V_{DD}$ = 15V, $V_{OUT}$ = 1.5V or 13.8V | 11.0 | | 11.0 | 9 | | 11.0 | | |
| $V_{OH}$ | Output | $V_{DD}$ = 5V, $I_{OH}$ = 0 mA | 4.1 | | 4.1 | 4.57 | | 4.1 | | |
| | (Source) Drive | $V_{DD}$ = 5V, $I_{OH}$ = 5 mA | | | | 4.24 | | | | |
| | Voltage | $V_{DD}$ = 5V, $I_{OH}$ = 10 mA | 3.9 | | 3.9 | 4.12 | | 3.5 | | V |
| | | $V_{DD}$ = 5V, $I_{OH}$ = 15 mA | | | | 3.94 | | | | |
| | | $V_{DD}$ = 5V, $I_{OH}$ = 20 mA | 3.4 | | 3.4 | 3.75 | | 3.0 | | |
| | | $V_{DD}$ = 5V, $I_{OH}$ = 25 mA | | | | 3.54 | | | | |
| | | $V_{DD}$ = 10V, $I_{OH}$ = 0 mA | 9.1 | | 9.1 | 9.58 | | 9.1 | | |
| | | $V_{DD}$ = 10V, $I_{OH}$ = 5 mA | | | | 9.26 | | | | |
| | | $V_{DD}$ = 10V, $I_{OH}$ = 10 mA | 9.0 | | 9.0 | 9.17 | | 8.6 | | V |
| | | $V_{DD}$ = 10V, $I_{OH}$ = 15 mA | | | | 9.04 | | | | |
| | | $V_{DD}$ = 10V, $I_{OH}$ = 20 mA | 8.6 | | 8.6 | 8.9 | | 8.2 | | |
| | | $V_{DD}$ = 10V, $I_{OH}$ = 25 mA | | | | 8.75 | | | | |
| | | $V_{DD}$ = 15V, $I_{OH}$ = 0 mA | 14.1 | | 14.1 | 9.58 | | 14.1 | | |
| | | $V_{DD}$ = 15V, $I_{OH}$ = 5 mA | | | | 14.27 | | | | |
| | | $V_{DD}$ = 15V, $I_{OH}$ = 10 mA | 14.0 | | 14.0 | 14.17 | | 13.6 | | V |
| | | $V_{DD}$ = 15V, $I_{OH}$ = 15 mA | | | | 14.07 | | | | |
| | | $V_{DD}$ = 15V, $I_{OH}$ = 20 mA | 13.6 | | 13.6 | 13.95 | | 13.2 | | |
| | | $V_{DD}$ = 15V, $I_{OH}$ = 25 mA | | | | 13.80 | | | | |
| $I_{OL}$ | LOW Level | $V_{DD}$ = 5V, $V_{OL}$ = 0.4V | 0.64 | | 0.51 | 0.88 | | 0.36 | | |
| | Output Current | $V_{DD}$ = 10V, $V_{OL}$ = 0.5V | 1.6 | | 1.3 | 2.25 | | 0.9 | | mA |
| | | $V_{DD}$ = 15V, $V_{OL}$ = 1.5V | 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 | |

## AC Electrical Characteristics (Note 2)

$T_A = 25°C$ and $C_L = 50$ pF, typical temperature coefficient for all values of $V_{DD} = 0.3\%/°C$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN} = 0$ | | 5.0 | 7.5 | pF |
| $t_r$ | Output Rise Time | $V_{DD} = 5V$ | | 40 | 80 | |
| | (Figure 1**a**) | $V_{DD} = 10V$ | | 30 | 60 | ns |
| | | $V_{DD} = 15V$ | | 25 | 50 | |
| $t_f$ | Output Fall Time | $V_{DD} = 5V$ | | 125 | 250 | |
| | (Figure 1**a**) | $V_{DD} = 10V$ | | 75 | 150 | ns |
| | | $V_{DD} = 15V$ | | 65 | 130 | |
| $t_{PLH}$ | Turn-Off Delay Time | $V_{DD} = 5V$ | | 640 | 1280 | |
| | (Data) (Figure 1**a**) | $V_{DD} = 10V$ | | 250 | 500 | ns |
| | | $V_{DD} = 15V$ | | 175 | 350 | |
| $t_{PHL}$ | Turn-On Delay Time | $V_{DD} = 5V$ | | 720 | 1440 | |
| | (Data) (Figure 1**a**) | $V_{DD} = 10V$ | | 290 | 580 | ns |
| | | $V_{DD} = 15V$ | | 195 | 400 | |
| $t_{PLH}$ | Turn-Off Delay Time | $V_{DD} = 5V$ | | 320 | 640 | |
| | (Blank) (Figure 1**a**) | $V_{DD} = 10V$ | | 130 | 260 | ns |
| | | $V_{DD} = 15V$ | | 100 | 200 | |
| $t_{PHL}$ | Turn-On Delay Time | $V_{DD} = 5V$ | | 485 | 970 | |
| | (Blank) (Figure 1**a**) | $V_{DD} = 10V$ | | 200 | 400 | ns |
| | | $V_{DD} = 15V$ | | 160 | 320 | |
| $t_{PLH}$ | Turn-Off Delay Time | $V_{DD} = 5V$ | | 313 | 625 | |
| | (Lamp Test) (Figure 1**a**) | $V_{DD} = 10V$ | | 125 | 250 | ns |
| | | $V_{DD} = 15V$ | | 90 | 180 | |
| $t_{PHL}$ | Turn-On Delay Time | $V_{DD} = 5V$ | | 313 | 625 | |
| | (Lamp Test) (Figure 1 **a**) | $V_{DD} = 10V$ | | 125 | 250 | ns |
| | | $V_{DD} = 15V$ | | 90 | 180 | |
| $t_{SETUP}$ | Setup Time | $V_{DD} = 5V$ | 180 | 90 | | |
| | (Figure 1**b**) | $V_{DD} = 10V$ | 76 | 38 | | ns |
| | | $V_{DD} = 15V$ | 40 | 20 | | |
| $t_{HOLD}$ | Hold Time | $V_{DD} = 5V$ | 0 | –90 | | |
| | (Figure 1**b**) | $V_{DD} = 10V$ | 0 | –38 | | ns |
| | | $V_{DD} = 15V$ | 0 | –20 | | |
| $PW_{LE}$ | Minimum Latch Enable | $V_{DD} = 5V$ | 520 | 260 | | |
| | Pulse Width (Figure 1 **c**) | $V_{DD} = 10V$ | 220 | 110 | | ns |
| | | $V_{DD} = 15V$ | 130 | 65 | | |

**Note 2:** AC Parameters are guaranteed by DC correlated testing.

## Switching Time Waveforms

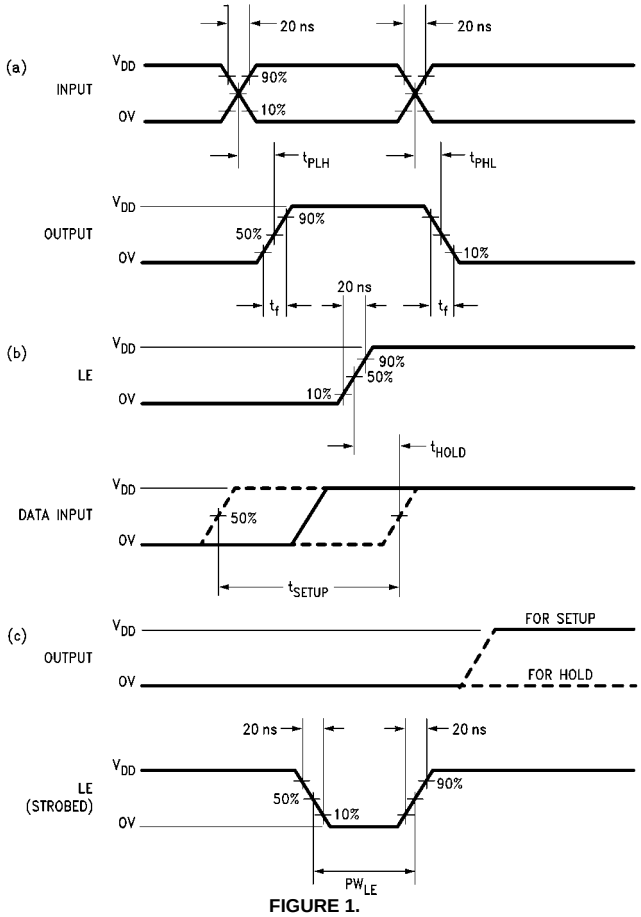
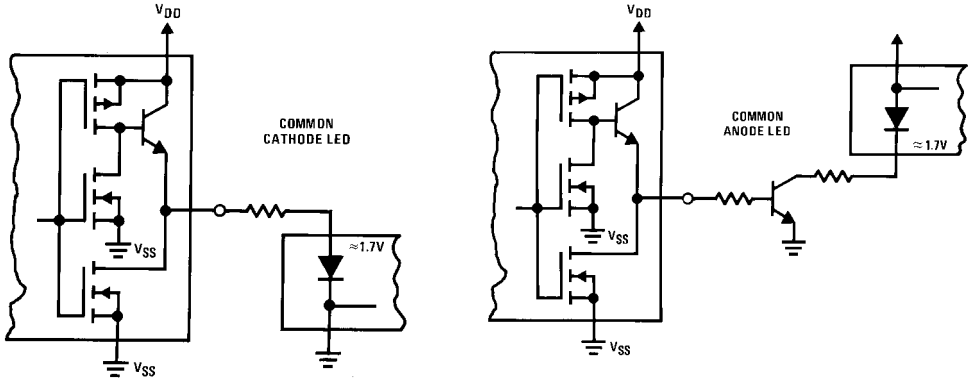


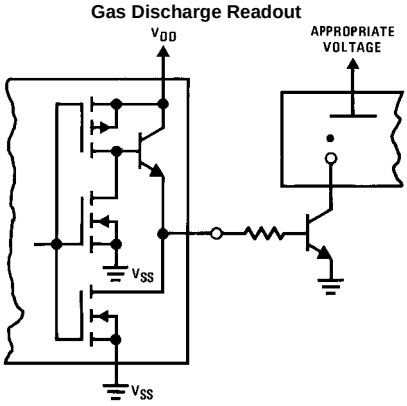

**FIGURE 1.**

## Typical Applications

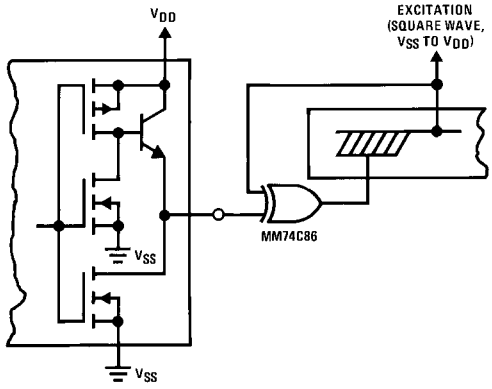
### Light Emitting Diode (LED) Readout




**Gas Discharge Readout**

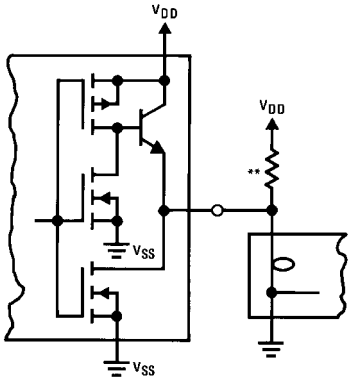



**Liquid Crystal (LC) Readout**

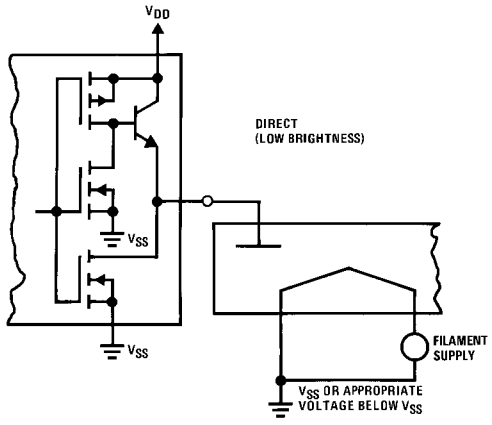



Direct DC drive of LC's not recommended for life of LC readouts.

**Incandescent Readout**

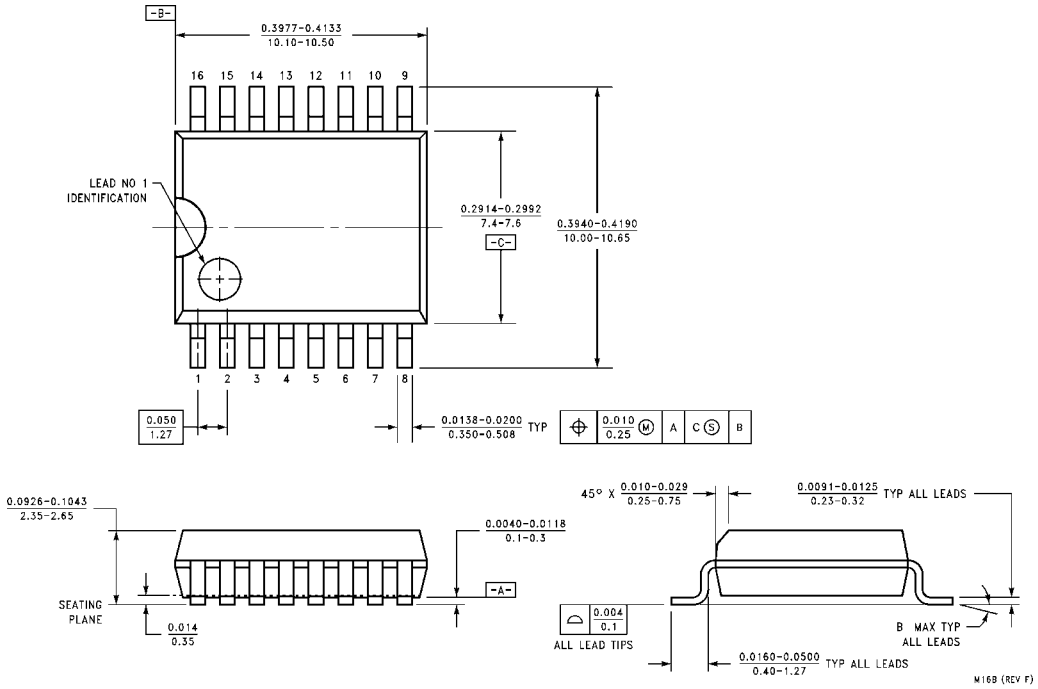



**Fluorescent Readout**



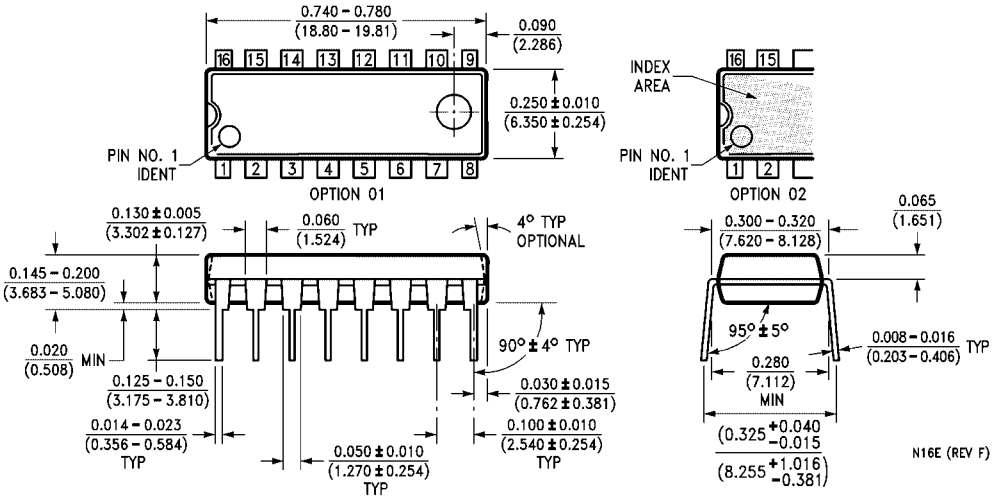

**A filament pre-warm resistor is recommended to reduce filament thermal shock and increase the effective cold resistance of the filament.

## Physical Dimensions inches (millimeters) unless otherwise noted




**16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide**
**Package Number M16B**

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




**16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide**
**Package Number N16E**

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