

54F/74F283 4-Bit Binary Full Adder with Fast Carry

General Description

The 'F283 high-speed 4-bit binary full adder with internal carry lookahead accepts two 4-bit binary words (A_0-A_3 , B_0-B_3) and a Carry input (C_0). It generates the binary Sum outputs (S_0-S_3) and the Carry output (C_4) from the most significant bit. The 'F283 will operate with either active HIGH or active LOW operands (positive or negative logic).

Features

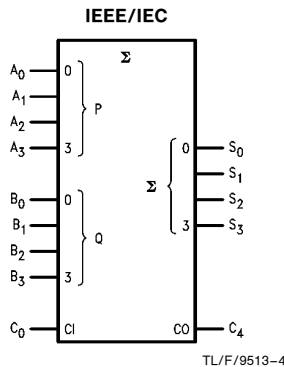
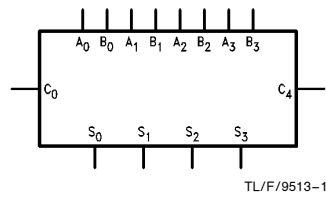
- Guaranteed 4000V minimum ESD protection

| Commercial | Military | Package Number | Package Description |
|-------------------|-------------------|----------------|---|
| 74F283PC | | N16E | 16-Lead (0.300" Wide) Molded Dual-In-Line |
| | 54F283DM (Note 2) | J16A | 16-Lead Ceramic Dual-In-Line |
| 74F283SC (Note 1) | | M16A | 16-Lead (0.150" Wide) Molded Small Outline, JEDEC |
| 74F283SJ (Note 1) | | M16D | 16-Lead (0.300" Wide) Molded Small Outline, EIAJ |
| | 54F283FM (Note 2) | W16A | 16-Lead Cerpack |
| | 54F283LL (Note 2) | E20A | 20-Lead Ceramic Leadless Chip Carrier, Type C |

Note 1: Devices also available in 13" reel. Use suffix = SCX and SJX.

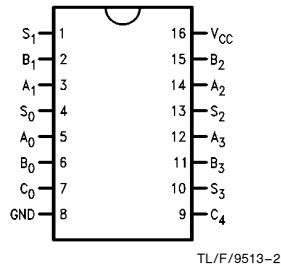
Note 2: Military grade device with environmental and burn-in processing. Use suffix = DMOB, FMQB and LMQB.

Logic Symbols

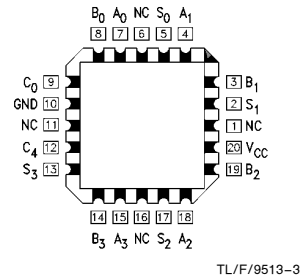


Connection Diagrams

Pin Assignment for DIP, SOIC and Flatpak



Pin Assignment for LCC



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Unit Loading/Fan Out

| Pin Names | Description | 54F/74F | |
|--------------------------------|------------------|------------------|---|
| | | U.L. HIGH/LOW | Input I_{IH}/I_{IL} Output I_{OH}/I_{OL} |
| A ₀ -A ₃ | A Operand Inputs | 1.0/2.0 | 20 μ A/ -1.2 mA |
| B ₀ -B ₃ | B Operand Inputs | 1.0/2.0 | 20 μ A/ -1.2 mA |
| C ₀ | Carry Input | 1.0/1.0 | 20 μ A/ -0.6 mA |
| S ₀ -S ₃ | Sum Outputs | 50/33.3 | -1 mA/20 mA |
| C ₄ | Carry Output | 50/33.3 | -1 mA/20 mA |

Functional Description

The 'F283 adds two 4-bit binary words (A plus B) plus the incoming Carry (C₀). The binary sum appears on the Sum (S₀-S₃) and outgoing carry (C₄) outputs. The binary weight of the various inputs and outputs is indicated by the subscript numbers, representing powers of two.

$$2^0 (A_0 + B_0 + C_0) + 2^1 (A_1 + B_1) + 2^2 (A_2 + B_2) + 2^3 (A_3 + B_3) = S_0 + 2S_1 + 4S_2 + 8S_3 + 16C_4$$

Where (+) = plus

Interchanging inputs of equal weight does not affect the operation. Thus C₀, A₀, B₀ can be arbitrarily assigned to pins 5, 6 and 7 for DIPs, and 7, 8 and 9 for chip carrier packages. Due to the symmetry of the binary add function, the 'F283 can be used either with all inputs and outputs active HIGH (positive logic) or with all inputs and outputs active LOW (negative logic). See *Figure 1*. Note that if C₀ is not used it must be tied LOW for active HIGH logic or tied HIGH for active LOW logic.

Due to pin limitations, the intermediate carries of the 'F283 are not brought out for use as inputs or outputs. However,

other means can be used to effectively insert a carry into, or bring a carry out from, an intermediate stage. *Figure 2* shows how to make a 3-bit adder. Tying the operand inputs of the fourth adder (A₃, B₃) LOW makes S₃ dependent only on, and equal to, the carry from the third adder. Using somewhat the same principle, *Figure 3* shows a way of dividing the 'F283 into a 2-bit and a 1-bit adder. The third stage adder (A₂, B₂, S₂) is used merely as a means of getting a carry (C₁₀) signal into the fourth stage (via A₂ and B₂) and bringing out the carry from the second stage on S₂. Note that as long as A₂ and B₂ are the same, whether HIGH or LOW, they do not influence S₂. Similarly, when A₂ and B₂ are the same the carry into the third stage does not influence the carry out of the third stage. *Figure 4* shows a method of implementing a 5-input encoder, where the inputs are equally weighted. The outputs S₀, S₁ and S₂ present a binary number equal to the number of inputs I₁-I₅ that are true. *Figure 5* shows one method of implementing a 5-input majority gate. When three or more of the inputs I₁-I₅ are true, the output M₅ is true.

| | C ₀ | A ₀ | A ₁ | A ₂ | A ₃ | B ₀ | B ₁ | B ₂ | B ₃ | S ₀ | S ₁ | S ₂ | S ₃ | C ₄ |
|--------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Logic Levels | L | L | H | L | H | H | L | L | H | H | H | L | L | H |
| Active HIGH | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| Active LOW | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |

Active HIGH: 0 + 10 + 9 = 3 + 16 Active LOW: 1 + 5 + 6 = 12 + 0

FIGURE 1. Active HIGH versus Active LOW Interpretation

Functional Description (Continued)

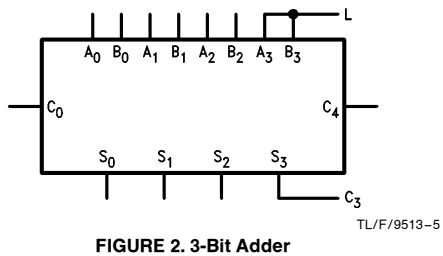


FIGURE 2. 3-Bit Adder

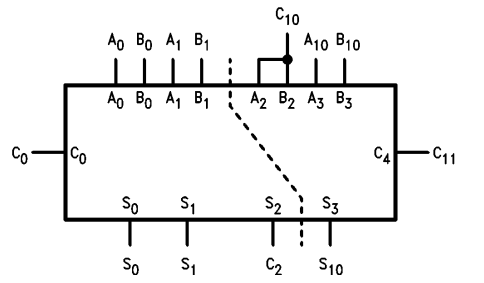


FIGURE 3. 2-Bit and 1-Bit Adders

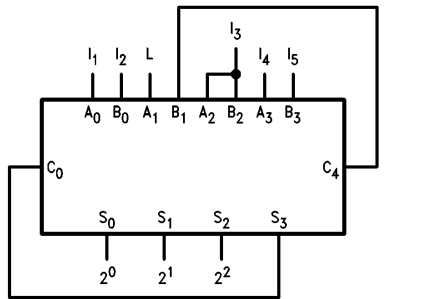


FIGURE 4. 5-Input Encoder

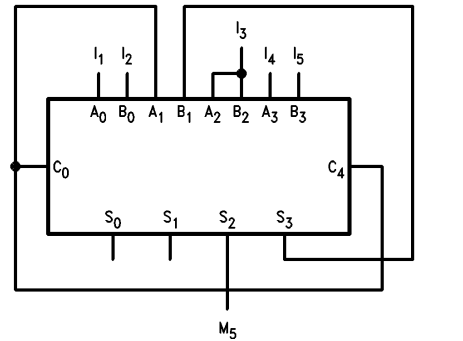
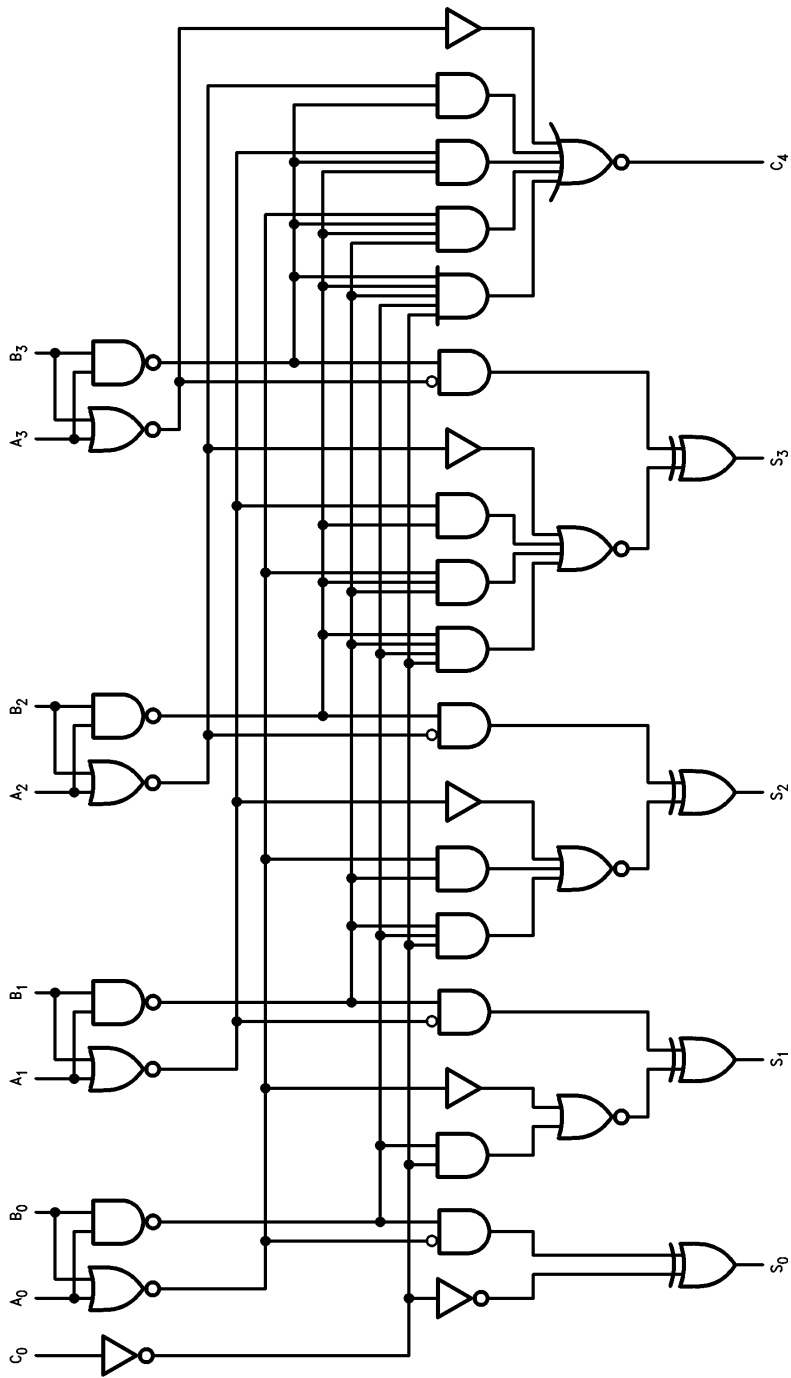


FIGURE 5. 5-Input Majority Gate

Logic Diagram



TL/F/9513-9

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)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

| | |
|---|--------------------------------------|
| Storage Temperature | -65°C to +150°C |
| Ambient Temperature under Bias | -55°C to +125°C |
| Junction Temperature under Bias | -55°C to +175°C |
| Plastic | -55°C to +150°C |
| V _{CC} Pin Potential to Ground Pin | -0.5V to +7.0V |
| Input Voltage (Note 2) | -0.5V to +7.0V |
| Input Current (Note 2) | -30 mA to +5.0 mA |
| Voltage Applied to Output in HIGH State (with V _{CC} = 0V) | |
| Standard Output | -0.5V to V _{CC} |
| TRI-STATE® Output | -0.5V to +5.5V |
| Current Applied to Output in LOW State (Max) | twice the rated I _{OL} (mA) |
| ESD Last Passing Voltage (Min) | 4000V |

Note 1: Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

Note 2: Either voltage limit or current limit is sufficient to protect inputs.

Recommended Operating Conditions

| | |
|------------------------------|-----------------|
| Free Air Ambient Temperature | |
| Military | -55°C to +125°C |
| Commercial | 0°C to +70°C |
| Supply Voltage | |
| Military | +4.5V to +5.5V |
| Commercial | +4.5V to +5.5V |

DC Electrical Characteristics

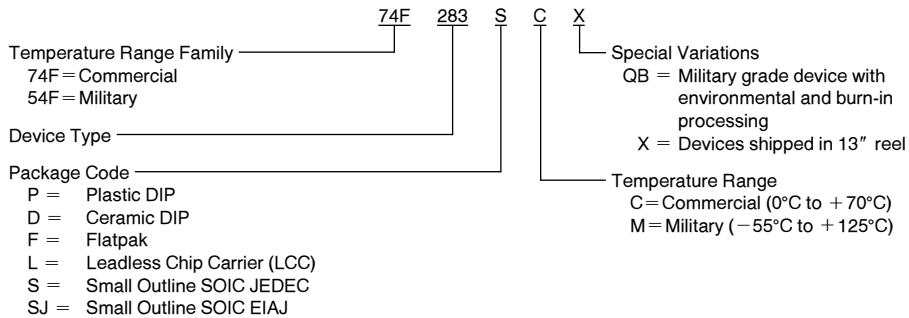
| Symbol | Parameter | 54F/74F | | | Units | V _{CC} | Conditions |
|------------------|-----------------------------------|-------------------------|------|--------------|-------|-----------------|---|
| | | Min | Typ | Max | | | |
| V _{IH} | Input HIGH Voltage | 2.0 | | | V | | Recognized as a HIGH Signal |
| V _{IL} | Input LOW Voltage | | | 0.8 | V | | Recognized as a LOW Signal |
| V _{CD} | Input Clamp Diode Voltage | | | -1.2 | V | Min | I _{IN} = -18 mA |
| V _{OH} | Output HIGH Voltage | 54F 10% V _{CC} | 2.5 | | V | Min | I _{OH} = -1 mA I _{OH} = -1 mA I _{OH} = -1 mA |
| | | 74F 10% V _{CC} | 2.5 | | | | |
| | | 74F 5% V _{CC} | 2.7 | | | | |
| V _{OL} | Output LOW Voltage | 54F 10% V _{CC} | | 0.5 | V | Min | I _{OL} = 20 mA I _{OL} = 20 mA |
| | | 74F 10% V _{CC} | | 0.5 | | | |
| I _{IH} | Input HIGH Current | 54F | | 20.0 | μA | Max | V _{IN} = 2.7V |
| | | 74F | | 5.0 | | | |
| I _{BVI} | Input HIGH Current Breakdown Test | 54F | | 100 | μA | Max | V _{IN} = 7.0V |
| | | 74F | | 7.0 | | | |
| I _{CEX} | Output HIGH Leakage Current | 54F | | 250 | μA | Max | V _{OUT} = V _{CC} |
| | | 74F | | 50 | | | |
| V _{ID} | Input Leakage Test | 74F | 4.75 | | V | 0.0 | I _{ID} = 1.9 μA All Other Pins Grounded |
| I _{OD} | Output Leakage Circuit Current | 74F | | 3.75 | μA | 0.0 | V _{IOD} = 150 mV All Other Pins Grounded |
| I _{IL} | Input LOW Current | | | -0.6 -1.2 | mA | Max | V _{IN} = 0.5V (C _O) V _{IN} = 0.5V (A _n , B _n) |
| I _{OS} | Output Short-Circuit Current | | -60 | -150 | mA | Max | V _{OUT} = 0V |
| I _{CCH} | Power Supply Current | | 36 | 55 | mA | Max | V _O = HIGH |
| I _{CCL} | Power Supply Current | | 36 | 55 | mA | Max | V _O = LOW |

AC Electrical Characteristics

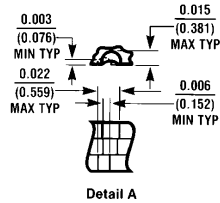
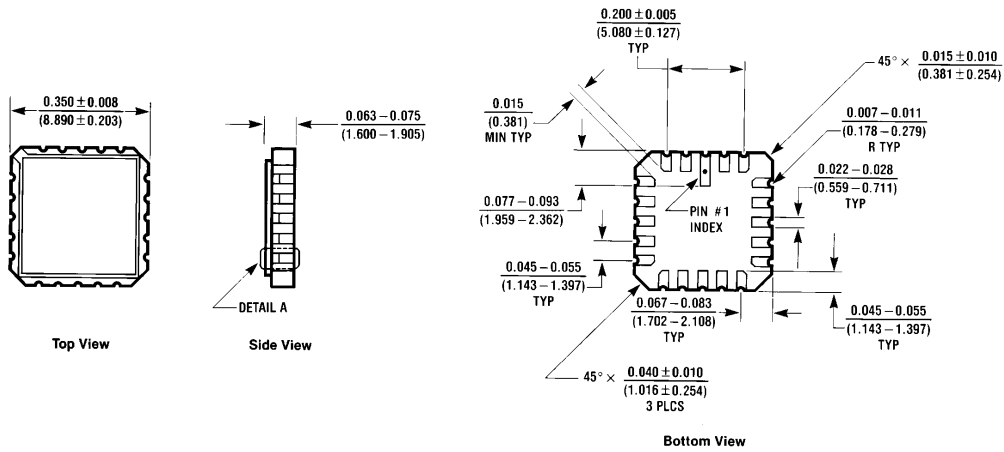
| Symbol | Parameter | 74F | | | 54F | | 74F | | Units |
|--------------------------------------|---|---|------------|------------|--|--------------|--|--------------|-------|
| | | T _A = +25°C V _{CC} = +5.0V C _L = 50 pF | | | T _A , V _{CC} = Mil C _L = 50 pF | | T _A , V _{CC} = Com C _L = 50 pF | | |
| | | Min | Typ | Max | Min | Max | Min | Max | |
| t _{PLH} t _{PHL} | Propagation Delay C ₀ to S _n | 3.5 3.0 | 7.0 7.0 | 9.5 9.5 | 3.5 3.0 | 14.0 14.0 | 3.5 3.0 | 11.0 11.0 | ns |
| t _{PLH} t _{PHL} | Propagation Delay A _n or B _n to S _n | 3.0 3.0 | 7.0 7.0 | 9.5 9.5 | 3.0 3.0 | 17.0 14.0 | 3.0 3.0 | 13.0 11.5 | ns |
| t _{PLH} t _{PHL} | Propagation Delay C ₀ to C ₄ | 3.0 3.0 | 5.7 5.4 | 7.5 7.0 | 3.0 2.5 | 10.5 10.0 | 3.0 3.0 | 8.5 8.0 | ns |
| t _{PLH} t _{PHL} | Propagation Delay A _n or B _n to C ₄ | 3.0 2.5 | 5.7 5.3 | 7.5 7.0 | 3.0 2.5 | 10.5 10.0 | 3.0 2.5 | 8.5 8.0 | ns |

Ordering Information

The device number is used to form part of a simplified purchasing code where the package type and temperature range are defined as follows:

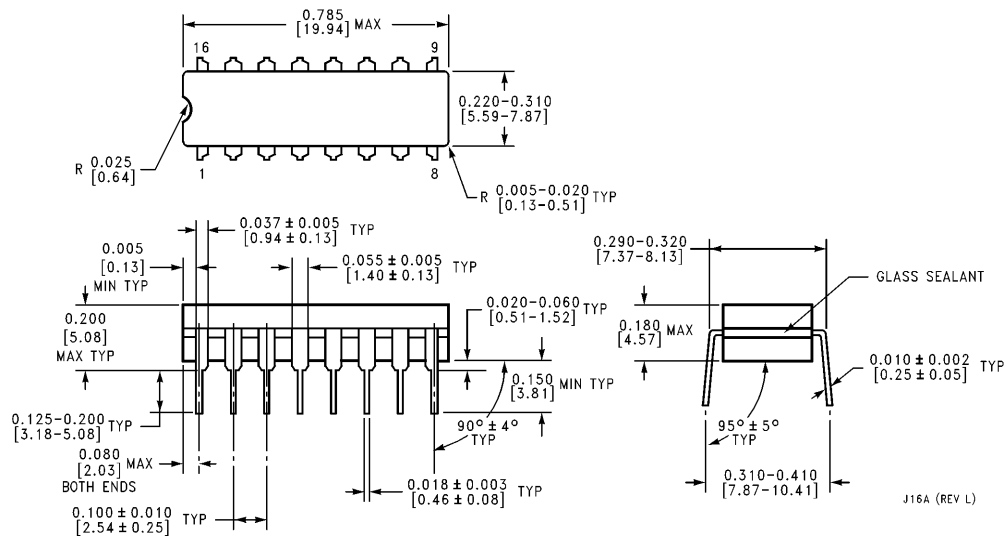


Physical Dimensions inches (millimeters)



20-Lead Ceramic Leadless Chip Carrier (L)
NS Package Number E20A

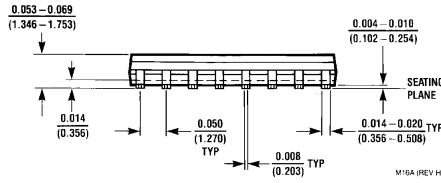
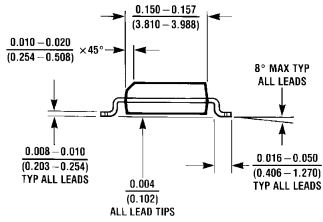
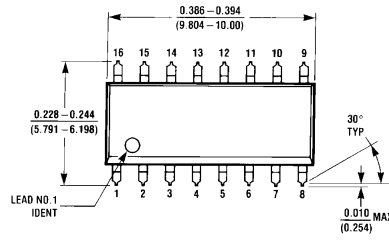
E20A (REV D)



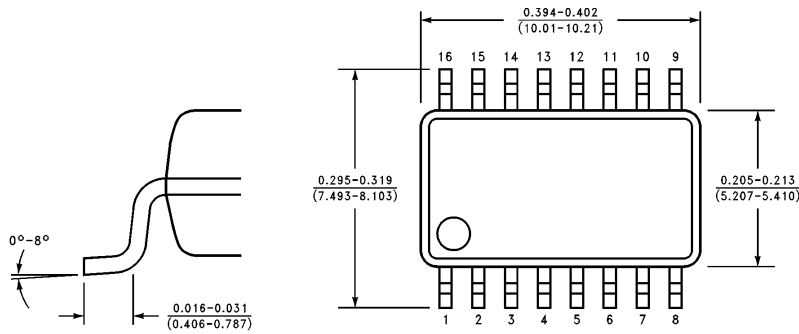
16-Lead Ceramic Dual-In-Line Package (D)
NS Package Number J16A

J16A (REV L)

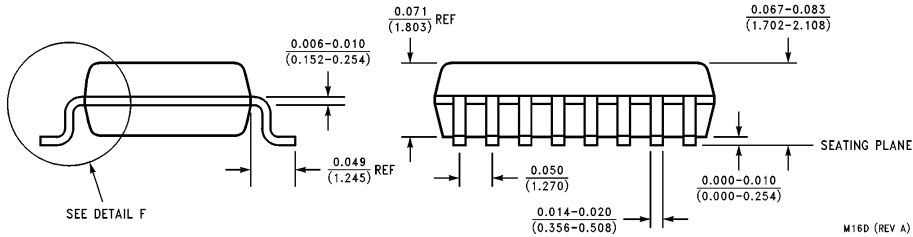
Physical Dimensions inches (millimeters) (Continued)



**16-Lead (0.150" Wide) Molded Small Outline Package, JEDEC (S)
NS Package Number M16A**



DETAIL F

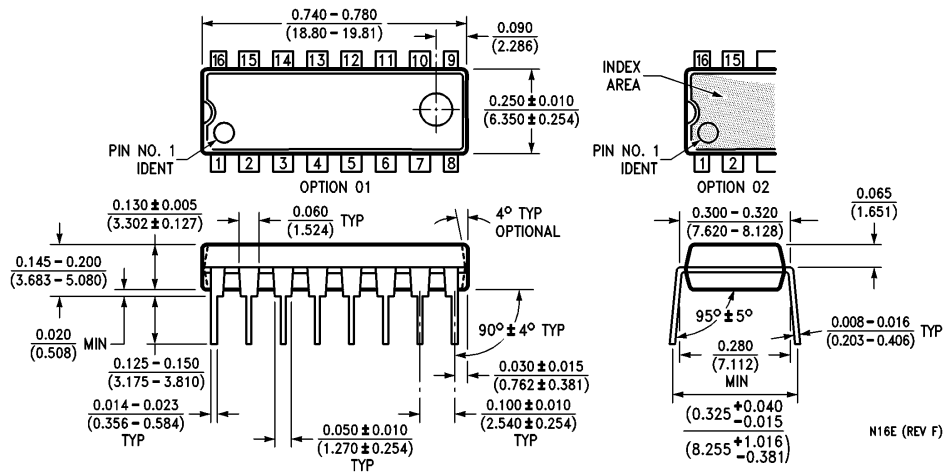


SEE DETAIL F

**16-Lead (0.300" Wide) Molded Small Outline Package, EIAJ (SJ)
NS Package Number M16D**

M16D (REV A)

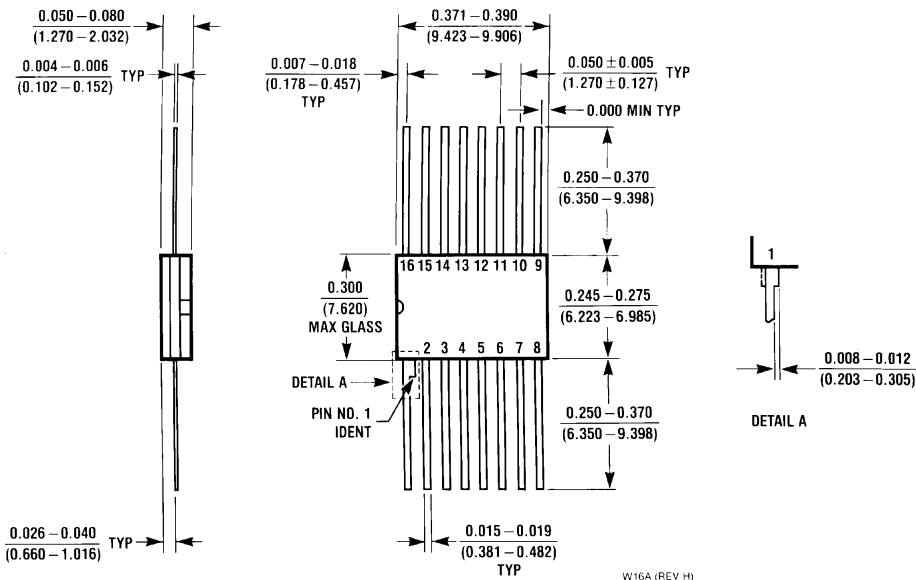
Physical Dimensions inches (millimeters) (Continued)



16-Lead (0.300" Wide) Molded Dual-In-Line Package (P)
NS Package Number N16E

N16E (REV F)

Physical Dimensions inches (millimeters) (Continued)



**16-Lead Ceramic Flatpak (F)
NS Package Number W16A**

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