

# LM741

## Operational Amplifier

### General Description

The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications. The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and

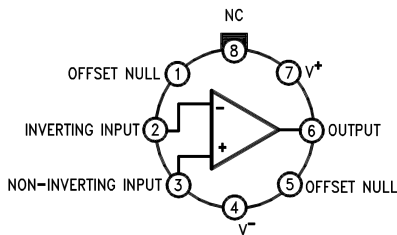
output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

The LM741C is identical to the LM741/LM741A except that the LM741C has their performance guaranteed over a 0°C to +70°C temperature range, instead of -55°C to +125°C.

### Features

### Connection Diagrams

**Metal Can Package**

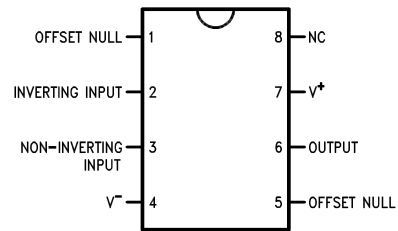


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Note 1: LM741H is available per JM38510/10101

**Order Number LM741H, LM741H/883 (Note 1),  
LM741AH/883 or LM741CH**  
See NS Package Number H08C

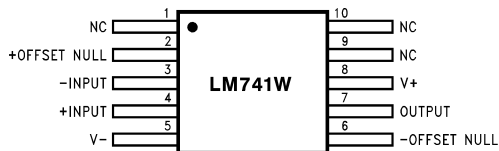
**Dual-In-Line or S.O. Package**



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**Order Number LM741J, LM741J/883, LM741CN**  
See NS Package Number J08A, M08A or N08E

**Ceramic Flatpak**

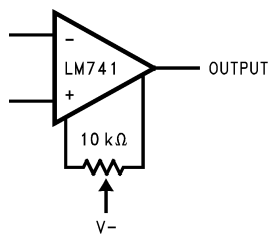


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**Order Number LM741W/883**  
See NS Package Number W10A

### Typical Application

**Offset Nulling Circuit**



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## Absolute Maximum Ratings (Note 2)

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

(Note 7)

|   | LM741A          | LM741           | LM741C          |
|---|-----------------|-----------------|-----------------|
| Supply Voltage  | ±22V            | ±22V            | ±18V            |
| Power Dissipation (Note 3)  | 500 mW          | 500 mW          | 500 mW          |
| Differential Input Voltage  | ±30V            | ±30V            | ±30V            |
| Input Voltage (Note 4)  | ±15V            | ±15V            | ±15V            |
| Output Short Circuit Duration   | Continuous      | Continuous      | Continuous      |
| Operating Temperature Range   | -55°C to +125°C | -55°C to +125°C | 0°C to +70°C    |
| Storage Temperature Range   | -65°C to +150°C | -65°C to +150°C | -65°C to +150°C |
| Junction Temperature  | 150°C           | 150°C           | 100°C           |
| Soldering Information   |                 |                 |                 |
| N-Package (10 seconds)  | 260°C           | 260°C           | 260°C           |
| J- or H-Package (10 seconds)  | 300°C           | 300°C           | 300°C           |
| M-Package   |                 |                 |                 |
| Vapor Phase (60 seconds)  | 215°C           | 215°C           | 215°C           |
| Infrared (15 seconds)   | 215°C           | 215°C           | 215°C           |
| See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices. |                 |                 |                 |
| ESD Tolerance (Note 8)  | 400V            | 400V            | 400V            |

## Electrical Characteristics (Note 5)

| Parameter                             | Conditions   | LM741A |     |       | LM741 |     |     | LM741C |     |     | Units                        |
|---------------------------------------|--|--------|-----|-------|-------|-----|-----|--------|-----|-----|------------------------------|
|                                       |  | Min    | Typ | Max   | Min   | Typ | Max | Min    | Typ | Max |                              |
| Input Offset Voltage                  | $T_A = 25^\circ\text{C}$<br>$R_S \leq 10\text{ k}\Omega$<br>$R_S \leq 50\Omega$          |        | 0.8 | 3.0   |       | 1.0 | 5.0 |        | 2.0 | 6.0 | mV                           |
|                                       | $T_{AMIN} \leq T_A \leq T_{AMAX}$<br>$R_S \leq 50\Omega$<br>$R_S \leq 10\text{ k}\Omega$ |        |     | 4.0   |       |     | 6.0 |        |     | 7.5 | mV                           |
|                                       |  |        |     |       |       |     |     |        |     |     |                              |
| Average Input Offset Voltage Drift    |  |        |     | 15    |       |     |     |        |     |     | $\mu\text{V}/^\circ\text{C}$ |
| Input Offset Voltage Adjustment Range | $T_A = 25^\circ\text{C}$ , $V_S = \pm 20\text{V}$  | ±10    |     |       |       | ±15 |     |        | ±15 |     | mV                           |
| Input Offset Current                  | $T_A = 25^\circ\text{C}$   |        | 3.0 | 30    |       | 20  | 200 |        | 20  | 200 | nA                           |
|                                       | $T_{AMIN} \leq T_A \leq T_{AMAX}$  |        |     | 70    |       | 85  | 500 |        |     | 300 | nA                           |
| Average Input Offset Current Drift    |  |        |     | 0.5   |       |     |     |        |     |     | $\text{nA}/^\circ\text{C}$   |
| Input Bias Current                    | $T_A = 25^\circ\text{C}$   |        | 30  | 80    |       | 80  | 500 |        | 80  | 500 | nA                           |
|                                       | $T_{AMIN} \leq T_A \leq T_{AMAX}$  |        |     | 0.210 |       |     | 1.5 |        |     | 0.8 | $\mu\text{A}$                |
| Input Resistance                      | $T_A = 25^\circ\text{C}$ , $V_S = \pm 20\text{V}$  | 1.0    | 6.0 |       | 0.3   | 2.0 |     | 0.3    | 2.0 |     | $\text{M}\Omega$             |
|                                       | $T_{AMIN} \leq T_A \leq T_{AMAX}$ ,<br>$V_S = \pm 20\text{V}$                            | 0.5    |     |       |       |     |     |        |     |     | $\text{M}\Omega$             |
| Input Voltage Range                   | $T_A = 25^\circ\text{C}$   |        |     |       |       |     |     | ±12    | ±13 |     | V                            |
|                                       | $T_{AMIN} \leq T_A \leq T_{AMAX}$  |        |     |       | ±12   | ±13 |     |        |     |     | V                            |

## Electrical Characteristics (Note 5) (Continued)

| Parameter                      | Conditions   | LM741A                               |      |            | LM741                |                      |           | LM741C               |                      |     | Units            |  |
|--------------------------------|--|--------------------------------------|------|------------|----------------------|----------------------|-----------|----------------------|----------------------|-----|------------------|--|
|                                |  | Min                                  | Typ  | Max        | Min                  | Typ                  | Max       | Min                  | Typ                  | Max |                  |  |
| Large Signal Voltage Gain      | $T_A = 25^\circ\text{C}$ , $R_L \geq 2\text{ k}\Omega$<br>$V_S = \pm 20\text{V}$ , $V_O = \pm 15\text{V}$<br>$V_S = \pm 15\text{V}$ , $V_O = \pm 10\text{V}$               | 50                                   |      |            | 50                   | 200                  |           | 20                   | 200                  |     | V/mV<br>V/mV     |  |
|                                | $T_{AMIN} \leq T_A \leq T_{AMAX}$ ,<br>$R_L \geq 2\text{ k}\Omega$ ,<br>$V_S = \pm 20\text{V}$ , $V_O = \pm 15\text{V}$<br>$V_S = \pm 15\text{V}$ , $V_O = \pm 10\text{V}$ | 32                                   |      |            | 25                   |                      |           | 15                   |                      |     | V/mV<br>V/mV     |  |
|                                | $V_S = \pm 5\text{V}$ , $V_O = \pm 2\text{V}$  | 10                                   |      |            |                      |                      |           |                      |                      |     | V/mV             |  |
| Output Voltage Swing           | $V_S = \pm 20\text{V}$<br>$R_L \geq 10\text{ k}\Omega$<br>$R_L \geq 2\text{ k}\Omega$  | $\pm 16$<br>$\pm 15$                 |      |            |                      |                      |           |                      |                      |     | V<br>V           |  |
|                                | $V_S = \pm 15\text{V}$<br>$R_L \geq 10\text{ k}\Omega$<br>$R_L \geq 2\text{ k}\Omega$  |                                      |      |            | $\pm 12$<br>$\pm 10$ | $\pm 14$<br>$\pm 13$ |           | $\pm 12$<br>$\pm 10$ | $\pm 14$<br>$\pm 13$ |     | V<br>V           |  |
|                                |  |                                      |      |            |                      |                      |           |                      |                      |     |                  |  |
| Output Short Circuit Current   | $T_A = 25^\circ\text{C}$   | 10                                   | 25   | 35         |                      | 25                   |           |                      | 25                   |     | mA               |  |
|                                | $T_{AMIN} \leq T_A \leq T_{AMAX}$  | 10                                   |      | 40         |                      |                      |           |                      |                      |     | mA               |  |
| Common-Mode Rejection Ratio    | $T_{AMIN} \leq T_A \leq T_{AMAX}$<br>$R_S \leq 10\text{ k}\Omega$ , $V_{CM} = \pm 12\text{V}$  |                                      |      |            | 70                   | 90                   |           | 70                   | 90                   |     | dB               |  |
|                                | $R_S \leq 50\Omega$ , $V_{CM} = \pm 12\text{V}$  | 80                                   | 95   |            |                      |                      |           |                      |                      |     | dB               |  |
| Supply Voltage Rejection Ratio | $T_{AMIN} \leq T_A \leq T_{AMAX}$ ,<br>$V_S = \pm 20\text{V}$ to $V_S = \pm 5\text{V}$<br>$R_S \leq 50\Omega$  | 86                                   | 96   |            |                      |                      |           |                      |                      |     | dB               |  |
|                                | $R_S \leq 10\text{ k}\Omega$   |                                      |      |            | 77                   | 96                   |           | 77                   | 96                   |     | dB               |  |
| Transient Response             | $T_A = 25^\circ\text{C}$ , Unity Gain  | Rise Time                            | 0.25 | 0.8        |                      | 0.3                  |           |                      | 0.3                  |     | $\mu\text{s}$    |  |
|                                |  | Overshoot                            | 6.0  | 20         |                      | 5                    |           |                      | 5                    |     | %                |  |
| Bandwidth (Note 6)             | $T_A = 25^\circ\text{C}$   | 0.437                                | 1.5  |            |                      |                      |           |                      |                      |     | MHz              |  |
| Slew Rate                      | $T_A = 25^\circ\text{C}$ , Unity Gain  | 0.3                                  | 0.7  |            |                      | 0.5                  |           |                      | 0.5                  |     | V/ $\mu\text{s}$ |  |
| Supply Current                 | $T_A = 25^\circ\text{C}$   |                                      |      |            |                      | 1.7                  | 2.8       |                      | 1.7                  | 2.8 | mA               |  |
| Power Consumption              | $T_A = 25^\circ\text{C}$<br>$V_S = \pm 20\text{V}$<br>$V_S = \pm 15\text{V}$   |                                      | 80   | 150        |                      |                      |           |                      |                      |     | mW<br>mW         |  |
|                                | $V_S = \pm 20\text{V}$<br>$T_A = T_{AMIN}$<br>$T_A = T_{AMAX}$   |                                      |      | 165<br>135 |                      |                      |           |                      |                      |     | mW<br>mW         |  |
|                                | LM741A   | $V_S = \pm 20\text{V}$               |      |            |                      |                      |           |                      |                      |     |                  |  |
|                                |  | $T_A = T_{AMIN}$<br>$T_A = T_{AMAX}$ |      |            |                      |                      |           |                      |                      |     |                  |  |
| LM741                          | $V_S = \pm 15\text{V}$<br>$T_A = T_{AMIN}$<br>$T_A = T_{AMAX}$   |                                      |      |            |                      | 60<br>45             | 100<br>75 |                      |                      |     | mW<br>mW         |  |

**Note 2:** "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

## Electrical Characteristics (Note 5) (Continued)

**Note 3:** For operation at elevated temperatures, these devices must be derated based on thermal resistance, and  $T_j$  max. (listed under "Absolute Maximum Ratings").  $T_j = T_A + (\theta_{JA} P_D)$ .

| Thermal Resistance                  | Cerdip (J) | DIP (N) | HO8 (H) | SO-8 (M) |
|-------------------------------------|------------|---------|---------|----------|
| $\theta_{JA}$ (Junction to Ambient) | 100°C/W    | 100°C/W | 170°C/W | 195°C/W  |
| $\theta_{JC}$ (Junction to Case)    | N/A        | N/A     | 25°C/W  | N/A      |

**Note 4:** For supply voltages less than  $\pm 15V$ , the absolute maximum input voltage is equal to the supply voltage.

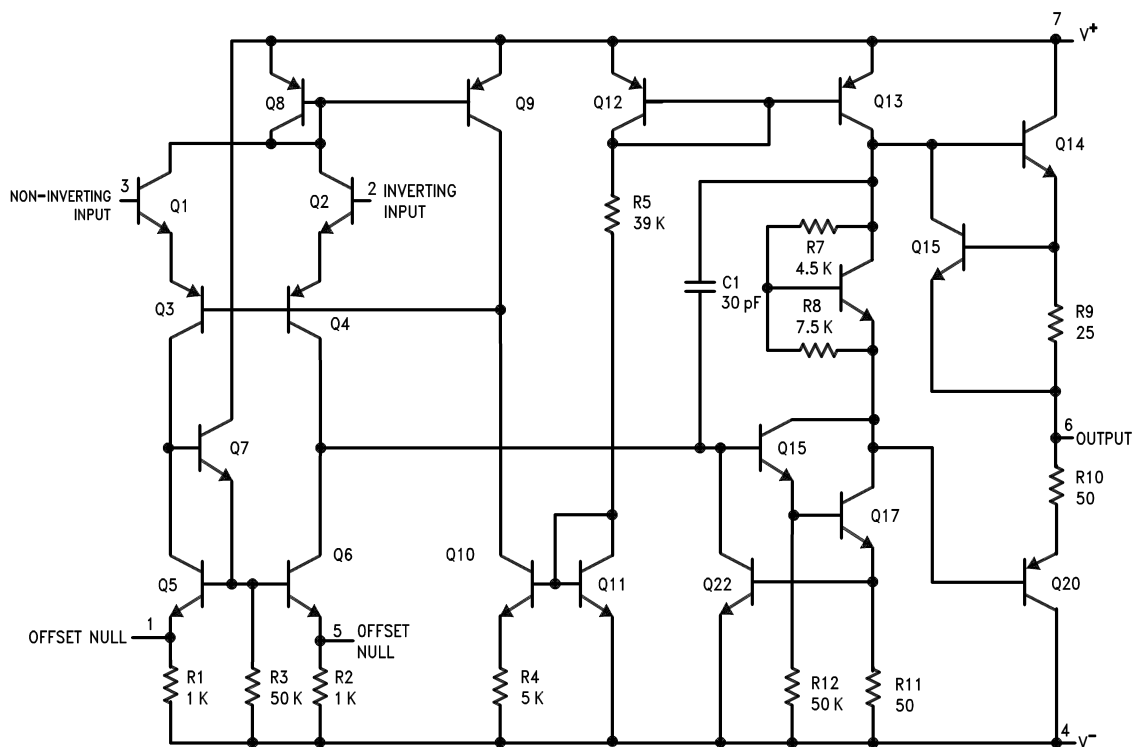
**Note 5:** Unless otherwise specified, these specifications apply for  $V_S = \pm 15V$ ,  $-55^\circ C \leq T_A \leq +125^\circ C$  (LM741/LM741A). For the LM741C/LM741E, these specifications are limited to  $0^\circ C \leq T_A \leq +70^\circ C$ .

**Note 6:** Calculated value from:  $BW$  (MHz) =  $0.35/\text{Rise Time}(\mu s)$ .

**Note 7:** For military specifications see RETS741X for LM741 and RETS741AX for LM741A.

**Note 8:** Human body model,  $1.5\text{ k}\Omega$  in series with  $100\text{ pF}$ .

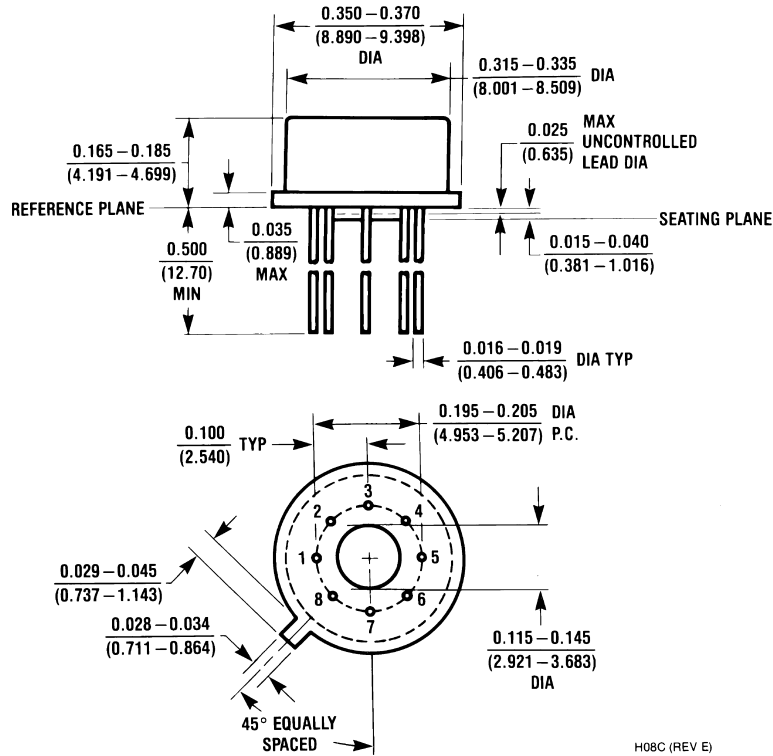
## Schematic Diagram



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**Physical Dimensions** inches (millimeters)

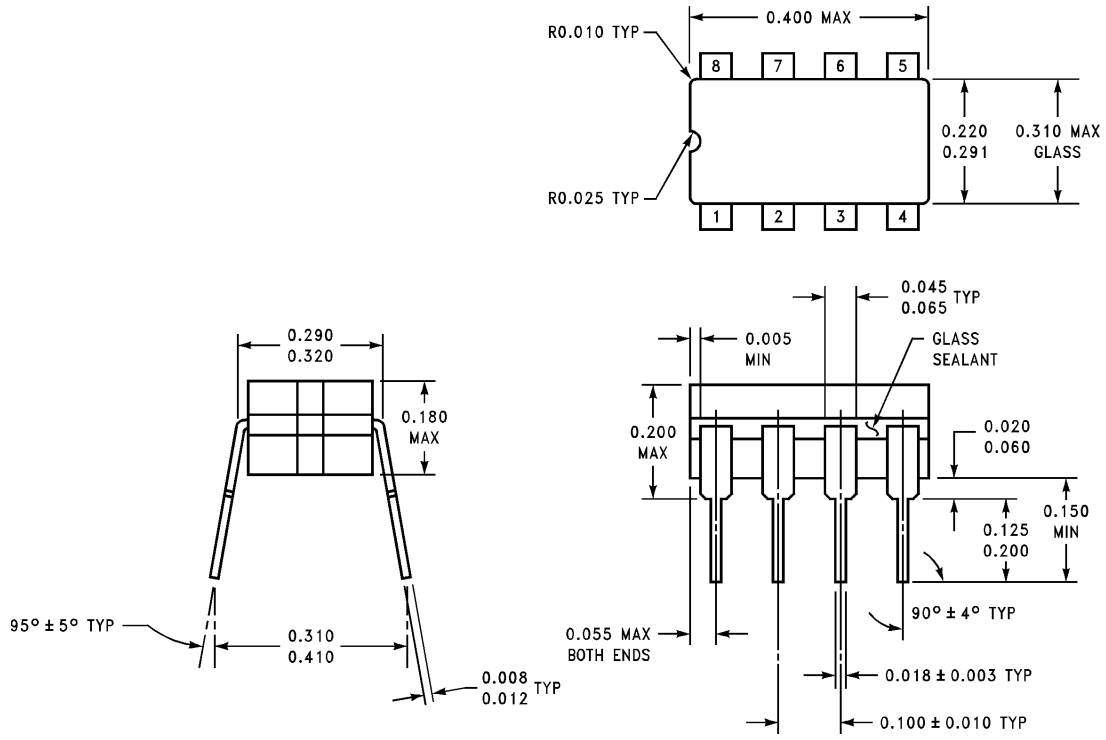
unless otherwise noted



H08C (REV E)

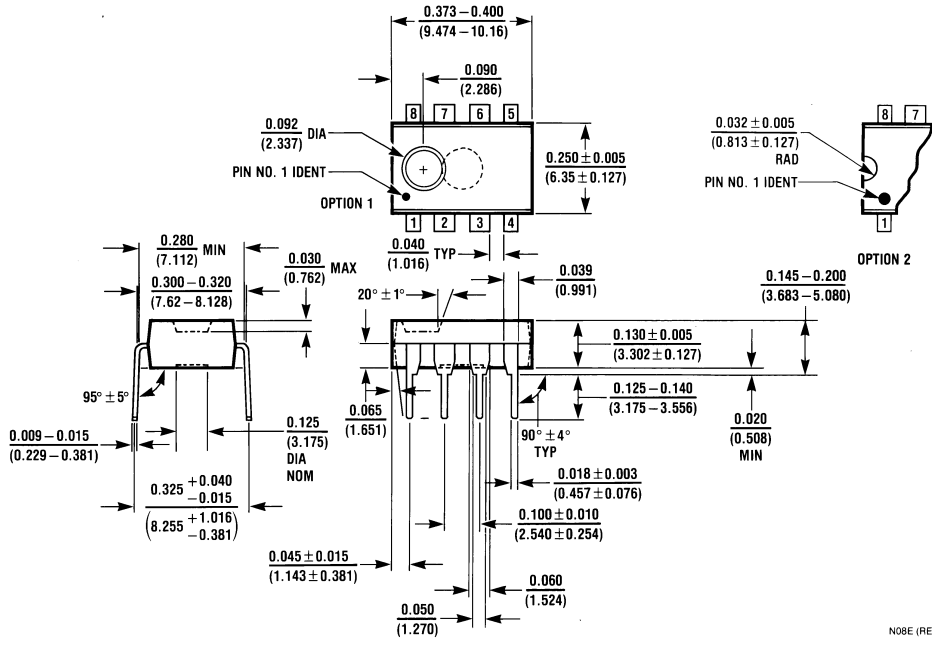
**Metal Can Package (H)**  
**Order Number LM741H, LM741H/883, LM741AH/883, LM741AH-MIL or LM741CH**  
**NS Package Number H08C**

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



J08A (REV K)

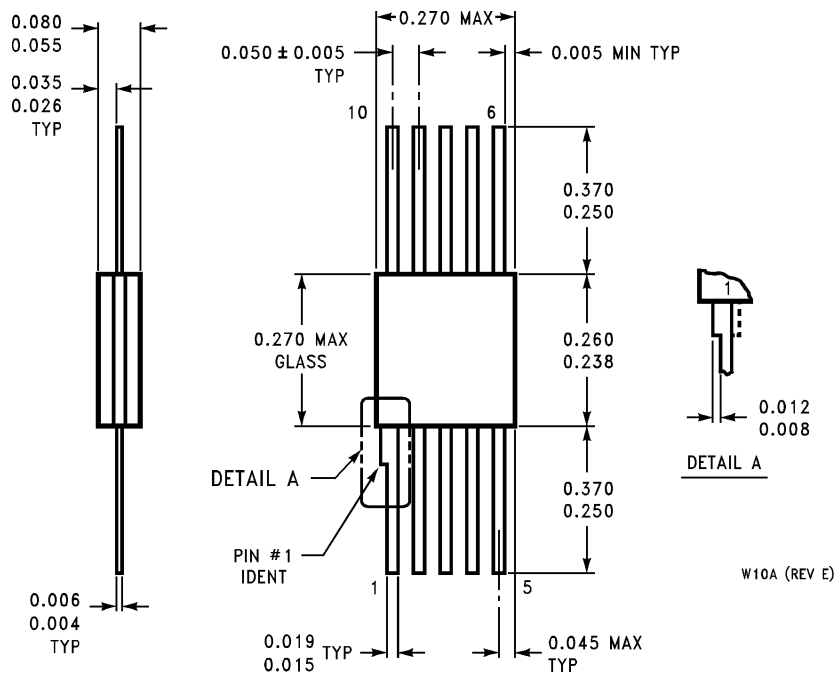
**Ceramic Dual-In-Line Package (J)**  
**Order Number LM741J/883**  
**NS Package Number J08A**



N08E (REV F)

**Dual-In-Line Package (N)**  
**Order Number LM741CN**  
**NS Package Number N08E**

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



**10-Lead Ceramic Flatpak (W)**  
**Order Number LM741W/883, LM741WG-MPR or LM741WG/883**  
**NS Package Number W10A**

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