

LM741 Operational Amplifier

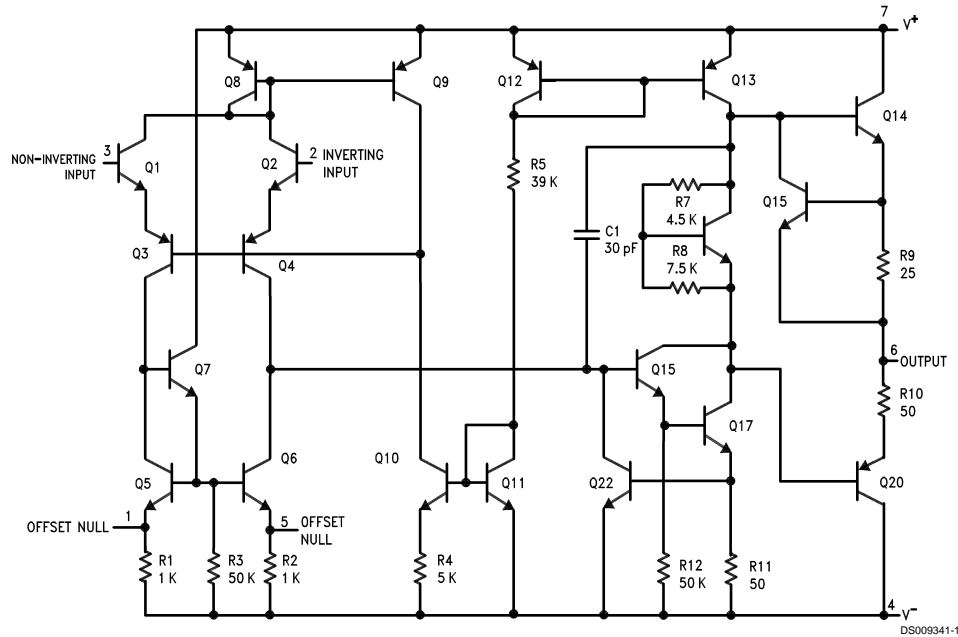
General Description

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.

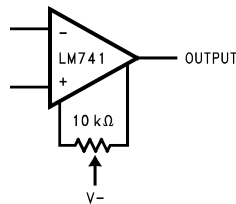
The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

The LM741C/LM741E are identical to the LM741/LM741A except that the LM741C/LM741E have their performance guaranteed over a 0°C to +70°C temperature range, instead of -55°C to +125°C.

Schematic Diagram



Offset Nulling Circuit



DS009341-7

Absolute Maximum Ratings (Note 1)

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

(Note 6)

| | LM741A | LM741E | LM741 | LM741C |
|---|-----------------|-----------------|-----------------|-----------------|
| Supply Voltage | ±22V | ±22V | ±22V | ±18V |
| Power Dissipation (Note 2) | 500 mW | 500 mW | 500 mW | 500 mW |
| Differential Input Voltage | ±30V | ±30V | ±30V | ±30V |
| Input Voltage (Note 3) | ±15V | ±15V | ±15V | ±15V |
| Output Short Circuit Duration | Continuous | Continuous | Continuous | Continuous |
| Operating Temperature Range | -55°C to +125°C | 0°C to +70°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 | -65°C to +150°C |
| Junction Temperature | 150°C | 100°C | 150°C | 100°C |
| Soldering Information | | | | |
| N-Package (10 seconds) | 260°C | 260°C | 260°C | 260°C |
| J- or H-Package (10 seconds) | 300°C | 300°C | 300°C | 300°C |
| M-Package | | | | |
| Vapor Phase (60 seconds) | 215°C | 215°C | 215°C | 215°C |
| Infrared (15 seconds) | 215°C | 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 7) | 400V | 400V | 400V | 400V |

Electrical Characteristics (Note 4)

| Parameter | Conditions | LM741A/LM741E | | | LM741 | | | LM741C | | | Units |
|---------------------------------------|---|---------------|-----|-------|-------|-----|-----|--------|-----|-----|------------------------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage | $T_A = 25^\circ\text{C}$ | | | | | | | | | | |
| | $R_S \leq 10\text{ k}\Omega$ | | 0.8 | 3.0 | | 1.0 | 5.0 | | 2.0 | 6.0 | mV |
| | $R_S \leq 50\Omega$ | | | | | | | | | | mV |
| Average Input Offset Voltage Drift | $T_{AMIN} \leq T_A \leq T_{AMAX}$ | | | 4.0 | | | | | | | mV |
| | $R_S \leq 50\Omega$ | | | | | | 6.0 | | | 7.5 | mV |
| | $R_S \leq 10\text{ k}\Omega$ | | | | | | | | | | $\mu\text{V}/^\circ\text{C}$ |
| 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 | μA |
| 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 | | $\text{M}\Omega$ |
| | $T_{AMIN} \leq T_A \leq T_{AMAX}, V_S = \pm 20\text{V}$ | 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 4) (Continued)

| Parameter | Conditions | LM741A/LM741E | | | LM741 | | | LM741C | | | Units |
|------------------------------|--|----------------------|------|------------|----------------------|----------------------|-----------|----------------------|----------------------|-----|------------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Large Signal Voltage Gain | $T_A = 25^\circ\text{C}$, $R_L \geq 2\text{ k}\Omega$ $V_S = \pm 20\text{V}$, $V_O = \pm 15\text{V}$ $V_S = \pm 15\text{V}$, $V_O = \pm 10\text{V}$ | 50 | | | 50 | 200 | | 20 | 200 | | V/mV V/mV |
| | $T_{AMIN} \leq T_A \leq T_{AMAX}$, $R_L \geq 2\text{ k}\Omega$, $V_S = \pm 20\text{V}$, $V_O = \pm 15\text{V}$ $V_S = \pm 15\text{V}$, $V_O = \pm 10\text{V}$ | 32 | | | 25 | | | 15 | | | V/mV V/mV |
| | $V_S = \pm 5\text{V}$, $V_O = \pm 2\text{V}$ | 10 | | | | | | | | | V/mV |
| Output Voltage Swing | $V_S = \pm 20\text{V}$ $R_L \geq 10\text{ k}\Omega$ $R_L \geq 2\text{ k}\Omega$ | ± 16 ± 15 | | | | | | | | | V V |
| | $V_S = \pm 15\text{V}$ $R_L \geq 10\text{ k}\Omega$ $R_L \geq 2\text{ k}\Omega$ | | | | ± 12 ± 10 | ± 14 ± 13 | | ± 12 ± 10 | ± 14 ± 13 | | V 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 | $T_{AMIN} \leq T_A \leq T_{AMAX}$ $R_S \leq 10\text{ k}\Omega$, $V_{CM} = \pm 12\text{V}$ $R_S \leq 50\Omega$, $V_{CM} = \pm 12\text{V}$ | 80 | 95 | | 70 | 90 | | 70 | 90 | | dB dB |
| | $T_{AMIN} \leq T_A \leq T_{AMAX}$, $V_S = \pm 20\text{V}$ to $V_S = \pm 5\text{V}$ $R_S \leq 50\Omega$ $R_S \leq 10\text{ k}\Omega$ | 86 | 96 | | 77 | 96 | | 77 | 96 | | dB dB |
| Transient Response | $T_A = 25^\circ\text{C}$, Unity Gain | Rise Time | 0.25 | 0.8 | | 0.3 | | | 0.3 | | μs |
| | | Overshoot | 6.0 | 20 | | 5 | | | 5 | | % |
| Bandwidth (Note 5) | $T_A = 25^\circ\text{C}$ | 0.437 | 1.5 | | | | | | | | MHz |
| Slew Rate | $T_A = 25^\circ\text{C}$, Unity Gain | 0.3 | 0.7 | | | 0.5 | | | 0.5 | | V/ μs |
| Supply Current | $T_A = 25^\circ\text{C}$ | | | | | 1.7 | 2.8 | | 1.7 | 2.8 | mA |
| Power Consumption | $T_A = 25^\circ\text{C}$ $V_S = \pm 20\text{V}$ $V_S = \pm 15\text{V}$ | | 80 | 150 | | | | | | | mW mW |
| | LM741A $V_S = \pm 20\text{V}$ $T_A = T_{AMIN}$ $T_A = T_{AMAX}$ | | | 165 135 | | | | | | | mW mW |
| LM741E | $V_S = \pm 20\text{V}$ $T_A = T_{AMIN}$ $T_A = T_{AMAX}$ | | | 150 150 | | | | | | | mW mW |
| | LM741 $V_S = \pm 15\text{V}$ $T_A = T_{AMIN}$ $T_A = T_{AMAX}$ | | | | | 60 45 | 100 75 | | | | mW mW |

Note 1: "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 4) (Continued)

Note 2: 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) |
|-------------------------------------|------------|---------|---------|----------|
| θ_{JA} (Junction to Ambient) | 100°C/W | 100°C/W | 170°C/W | 195°C/W |
| θ_{JC} (Junction to Case) | N/A | N/A | 25°C/W | N/A |

Note 3: For supply voltages less than $\pm 15V$, the absolute maximum input voltage is equal to the supply voltage.

Note 4: 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 $0^\circ C \leq T_A \leq +70^\circ C$.

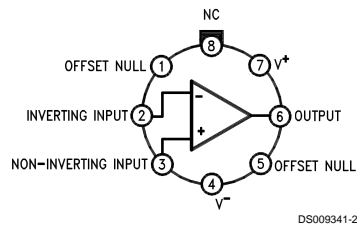
Note 5: Calculated value from: BW (MHz) = $0.35/\text{Rise Time}(\mu s)$.

Note 6: For military specifications see RETS741X for LM741 and RETS741AX for LM741A.

Note 7: Human body model, 1.5 k Ω in series with 100 pF.

Connection Diagram

Metal Can Package

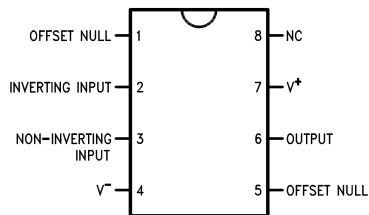


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Note 8: LM741H is available per JM38510/10101

**Order Number LM741H, LM741H/883 (Note 8),
LM741AH/883 or LM741CH
See NS Package Number H08C**

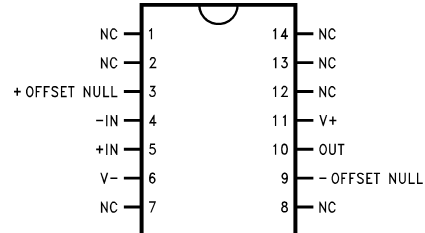
Dual-In-Line or S.O. Package



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**Order Number LM741J, LM741J/883,
LM741CM, LM741CN or LM741EN
See NS Package Number J08A, M08A or N08E**

Ceramic Dual-In-Line Package



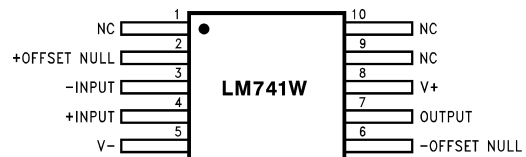
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Note 9: also available per JM38510/10101

Note 10: also available per JM38510/10102

**Order Number LM741J-14/883 (Note 9),
LM741AJ-14/883 (Note 10)
See NS Package Number J14A**

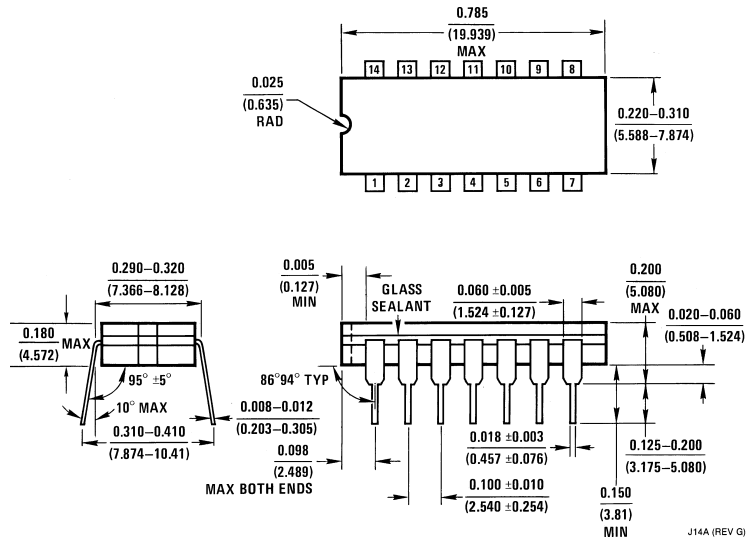
Ceramic Flatpak



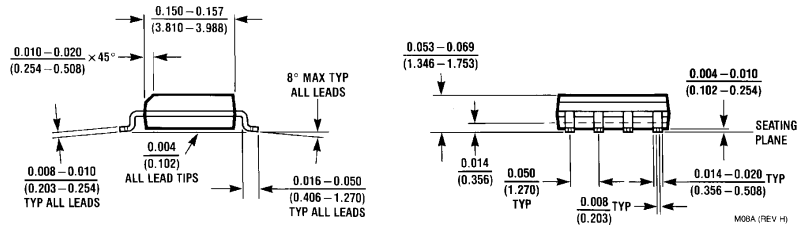
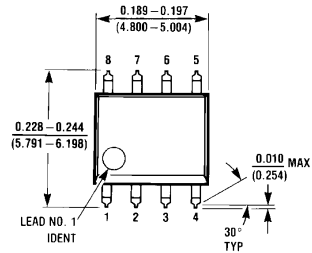
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**Order Number LM741W/883
See NS Package Number W10A**

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

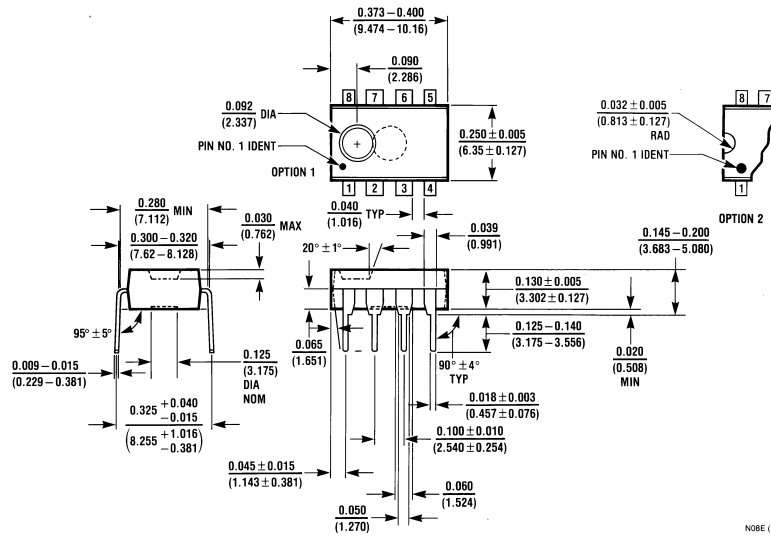


Ceramic Dual-In-Line Package (J)
Order Number LM741J-14/883 or LM741AJ-14/883
NS Package Number J14A



Small Outline Package (M)
Order Number LM741CM
NS Package Number M08A

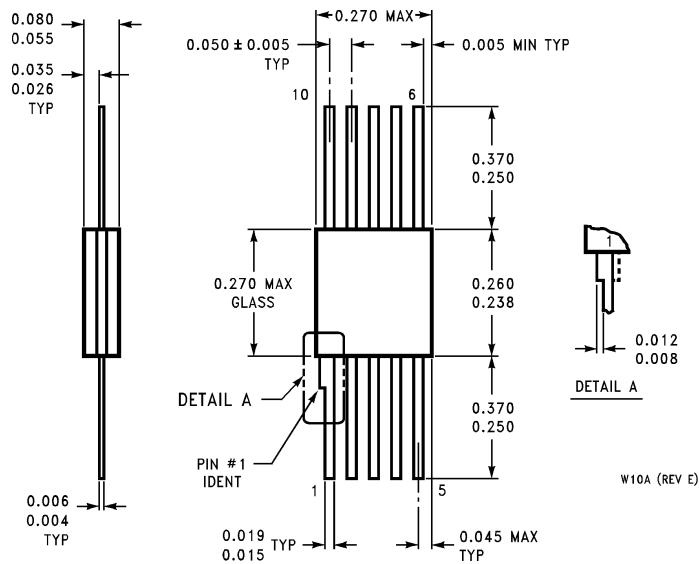
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Dual-In-Line Package (N)
Order Number LM741CN or LM741EN
NS Package Number N08E

N08E (REV F)

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



10-Lead Ceramic Flatpak (W)
Order Number LM741W/883
NS Package Number W10A

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