



May 1998

LM741 Operational Amplifier

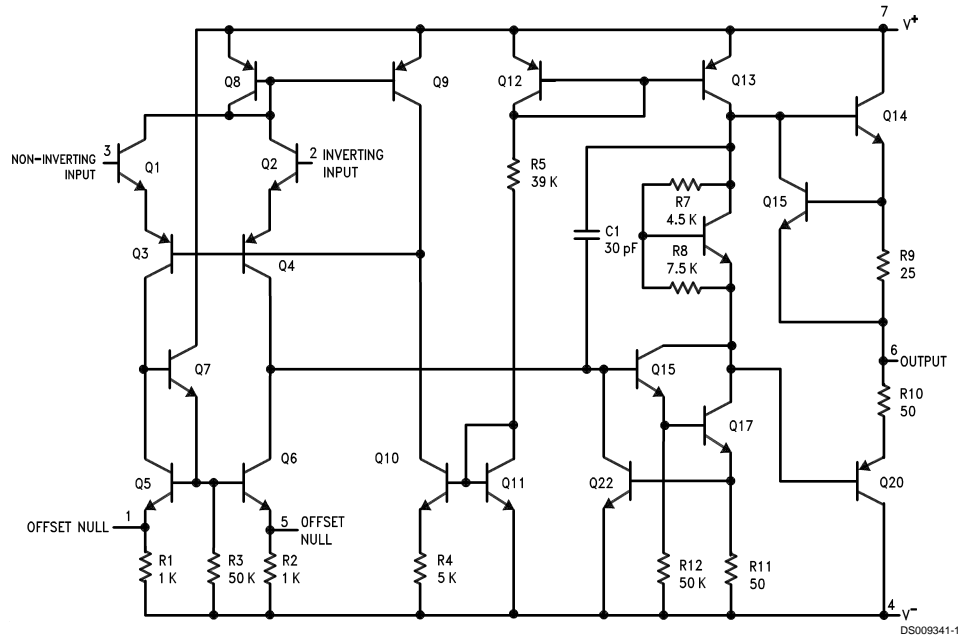
# LM741 Operational Amplifier

## General Description

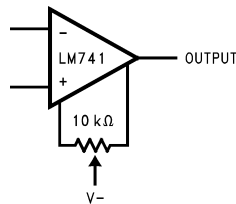
The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications. The amplifiers offer many features which make their application nearly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



## 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	$\mu\text{A}$
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		$\text{M}\Omega$
	$T_{AMIN} \leq T_A \leq T_{AMAX}, V_S = \pm 20\text{V}$	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	$V_S = \pm 20\text{V}$ $R_L \geq 10\text{ k}\Omega$ $R_L \geq 2\text{ k}\Omega$	$\pm 16$ $\pm 15$									V V
	$V_S = \pm 15\text{V}$ $R_L \geq 10\text{ k}\Omega$ $R_L \geq 2\text{ k}\Omega$				$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$		$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$		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		$\mu\text{s}$
		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/ $\mu\text{s}$
Supply Current	$T_A = 25^\circ\text{C}$					1.7	2.8		1.7	2.8	mA
Power Consumption	$T_A = 25^\circ\text{C}$ $V_S = \pm 20\text{V}$ $V_S = \pm 15\text{V}$		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)
$\theta_{JA}$ (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 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  $0^\circ C \leq T_A \leq +70^\circ C$ .

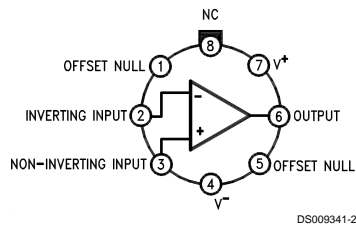
**Note 5:** Calculated value from:  $BW$  (MHz) =  $0.35/\text{Rise Time}(\mu s)$ .

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

**Note 7:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

## Connection Diagram

**Metal Can Package**

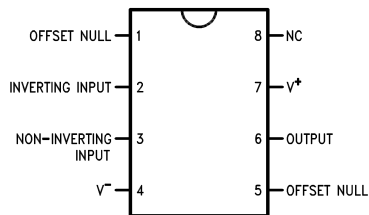


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**Note 8:** LM741H is available per JM38510/10101

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

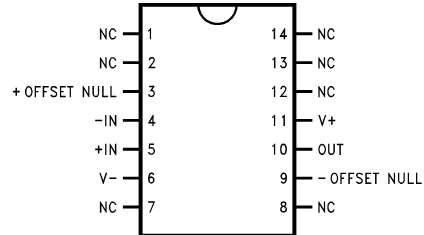
**Dual-In-Line or S.O. Package**



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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**



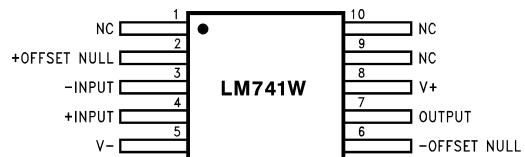
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**Note 9:** also available per JM38510/10101

**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**

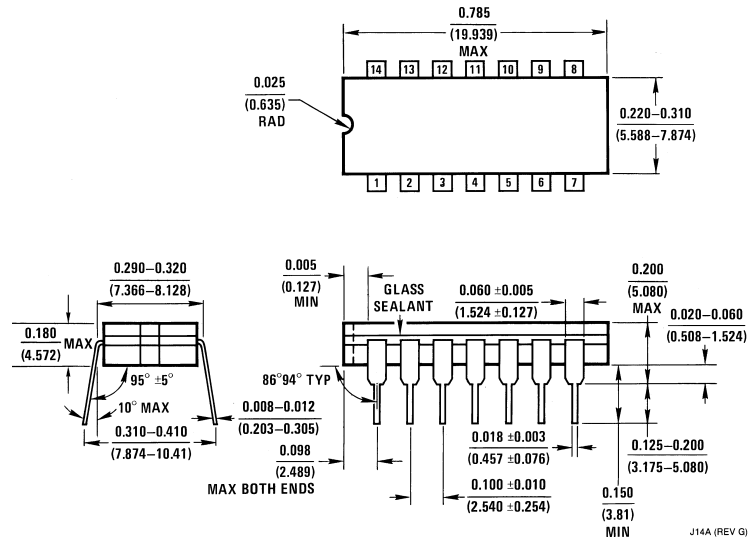


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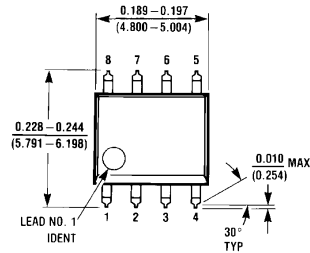
**Order Number LM741W/883  
See NS Package Number W10A**



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



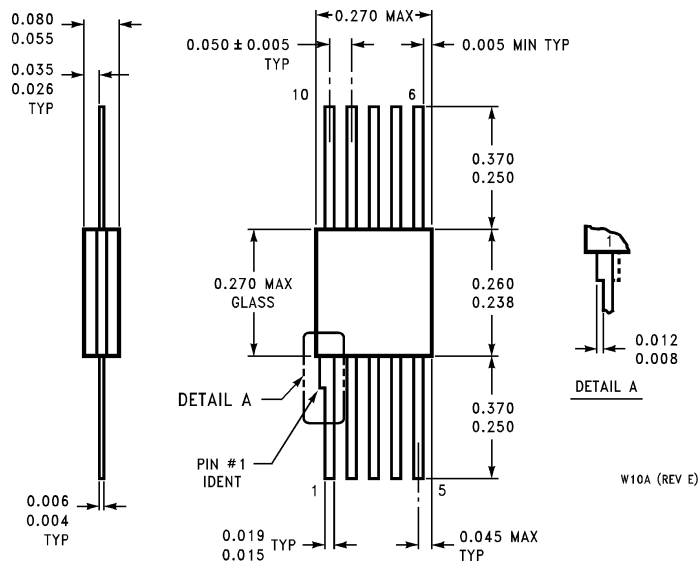
**Ceramic Dual-In-Line Package (J)**  
**Order Number LM741J-14/883 or LM741AJ-14/883**  
**NS Package Number J14A**



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



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




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

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