

## LM725 Operational Amplifier

### General Description

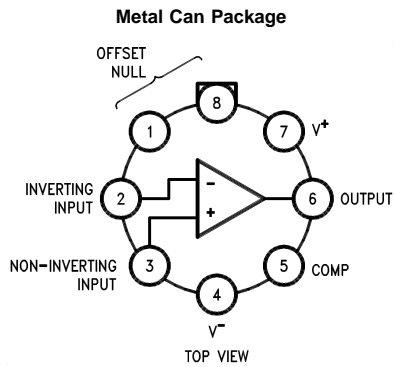
The LM725/LM725A/LM725C are operational amplifiers featuring superior performance in applications where low noise, low drift, and accurate closed-loop gain are required. With high common mode rejection and offset null capability, it is especially suited for low level instrumentation applications over a wide supply voltage range.

The LM725A has tightened electrical performance with higher input accuracy and like the LM725, is guaranteed over a  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range. The LM725C has slightly relaxed specifications and has its performance guaranteed over a  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  temperature range.

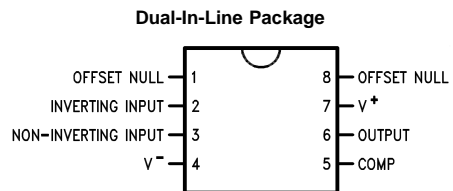
### Features

- High open loop gain 3,000,000
- Low input voltage drift  $0.6 \mu\text{V}/^{\circ}\text{C}$
- High common mode rejection 120 dB
- Low input noise current  $0.15 \text{ pA}/\sqrt{\text{Hz}}$
- Low input offset current 2 nA
- High input voltage range  $\pm 14\text{V}$
- Wide power supply range  $\pm 3\text{V}$  to  $\pm 22\text{V}$
- Offset null capability
- Output short circuit protection

### Connection Diagrams



Order Number LM725H/883, LM725CH  
or LM725AH/883  
See NS Package Number H08C



Order Number LM725CN  
See NS Package Number N08E

### Absolute Maximum Ratings (Note 1)

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

Supply Voltage	±22V
Internal Power Dissipation (Note 2)	500 mW
Differential Input Voltage	±5V
Input Voltage (Note 3)	±22V
Storage Temperature Range	-65°C to +150°C

Lead Temperature

(Soldering, 10 Sec.)

260°C

Maximum Junction Temperature

150°C

Operating Temperature Range

$T_{A(MIN)}$

$T_{A(MAX)}$

LM725

-55°C to +125°C

LM725A

-55°C to +125°C

LM725C

0°C to +70°C

### Electrical Characteristics (Note 4)

Parameter	Conditions	LM725A			LM725			LM725C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Without External Trim)	$T_A = 25^\circ\text{C}$ , $R_S \leq 10\text{ k}\Omega$			0.5		0.5	1.0		0.5	2.5	mV
Input Offset Current	$T_A = 25^\circ\text{C}$		2.0	5.0		2.0	20		2.0	35	nA
Input Bias Current	$T_A = 25^\circ\text{C}$		42	80		42	100		42	125	nA
Input Noise Voltage	$T_A = 25^\circ\text{C}$ $f_o = 10\text{ Hz}$ $f_o = 100\text{ Hz}$ $f_o = 1\text{ kHz}$		15			15			15		$\text{nV}/\sqrt{\text{Hz}}$
			9.0			9.0			9.0		$\text{nV}/\sqrt{\text{Hz}}$
			8.0			8.0			8.0		$\text{nV}/\sqrt{\text{Hz}}$
Input Noise Current	$T_A = 25^\circ\text{C}$ $f_o = 10\text{ Hz}$ $f_o = 100\text{ Hz}$ $f_o = 1\text{ kHz}$		1.0			1.0			1.0		$\text{pA}/\sqrt{\text{Hz}}$
			0.3			0.3			0.3		$\text{pA}/\sqrt{\text{Hz}}$
			0.15			0.15			0.15		$\text{pA}/\sqrt{\text{Hz}}$
Input Resistance	$T_A = 25^\circ\text{C}$		1.5			1.5			1.5		M $\Omega$
Input Voltage Range	$T_A = 25^\circ\text{C}$	±13.5	±14		±13.5	±14		±13.5	±14		V
Large Signal Voltage Gain	$T_A = 25^\circ\text{C}$ , $R_L \geq 2\text{ k}\Omega$ , $V_{OUT} = \pm 10\text{V}$	1000	3000		1000	3000		250	3000		V/mV
Common-Mode Rejection Ratio	$T_A = 25^\circ\text{C}$ , $R_S \leq 10\text{ k}\Omega$	120			110	120		94	120		dB
Power Supply Rejection Ratio	$T_A = 25^\circ\text{C}$ , $R_S \leq 10\text{ k}\Omega$		2.0	5.0		2.0	10		2.0	35	$\mu\text{V}/\text{V}$
Output Voltage Swing	$T_A = 25^\circ\text{C}$ , $R_L \geq 10\text{ k}\Omega$ $R_L \geq 2\text{ k}\Omega$	±12.5	±13.5		±12	±13.5		±12	±13.5		V
		±12.0	±13.5		±10	±13.5		±10	±13.5		V
Power Consumption	$T_A = 25^\circ\text{C}$		80	105		80	105		80	150	mW
Input Offset Voltage (Without External Trim)	$R_S \leq 10\text{ k}\Omega$			0.7			1.5			3.5	mV
Average Input Offset Voltage Drift (Without External Trim)	$R_S = 50\Omega$			2.0		2.0	5.0		2.0		$\mu\text{V}/^\circ\text{C}$
Average Input Offset Voltage Drift (With External Trim)	$R_S = 50\Omega$		0.6	1.0		0.6			0.6		$\mu\text{V}/^\circ\text{C}$
Input Offset Current	$T_A = T_{MAX}$ $T_A = T_{MIN}$		1.2	4.0		1.2	20		1.2	35	nA
			7.5	18.0		7.5	40		4.0	50	nA
Average Input Offset Current Drift			35	90		35	150		10		$\text{pA}/^\circ\text{C}$
Input Bias Current	$T_A = T_{MAX}$ $T_A = T_{MIN}$		20	70		20	100			125	nA
			80	180		80	200			250	nA

## Electrical Characteristics (Note 4) (Continued)

Parameter	Conditions	LM725A			LM725			LM725C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Large Signal Voltage Gain	$R_L \geq 2 \text{ k}\Omega$ $T_A = T_{MAX}$ $R_L \geq 2 \text{ k}\Omega$	1,000,000			1,000,000			125,000			V/V
	$T_A = T_{MIN}$ $R_L \geq 2 \text{ k}\Omega$	500,000			250,000			125,000			V/V
Common-Mode Rejection Ratio	$R_S \leq 10 \text{ k}\Omega$	110			100			115			dB
Power Supply Rejection Ratio	$R_S \leq 10 \text{ k}\Omega$	8.0			20			20			$\mu\text{V/V}$
Output Voltage Swing	$R_L \geq 2 \text{ k}\Omega$	$\pm 12$			$\pm 10$			$\pm 10$			V

**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.

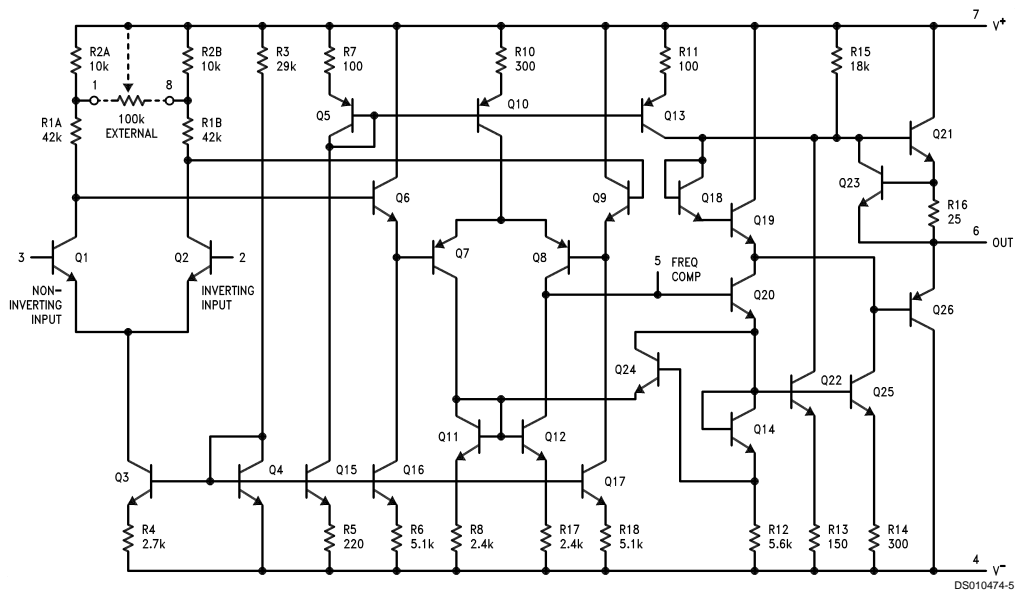
**Note 2:** Derate at 150°C/W for operation at ambient temperatures above 75°C.

**Note 3:** For supply voltages less than  $\pm 22\text{V}$ , the absolute maximum input voltage is equal to the supply voltage.

**Note 4:** These specifications apply for  $V_S = \pm 15\text{V}$  unless otherwise specified.

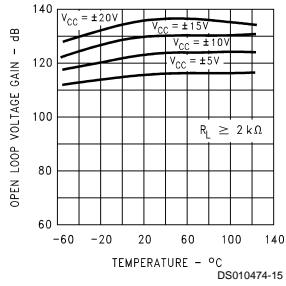
**Note 5:** For Military electrical specifications RETS725AX are available for LM725AH and RETS725X are available for LM725H.

## Schematic Diagram

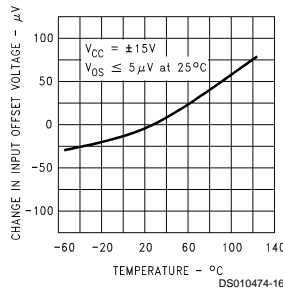


# Typical Performance Characteristics

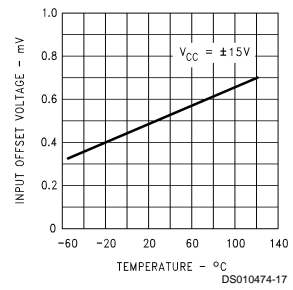
**Voltage Gain vs Temperature for Supply Voltages**



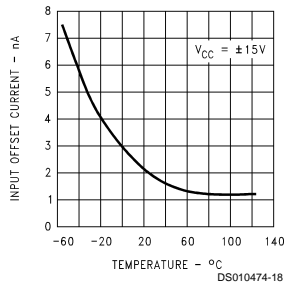
**Change in Trimmed Input Offset Voltage vs Temperature**



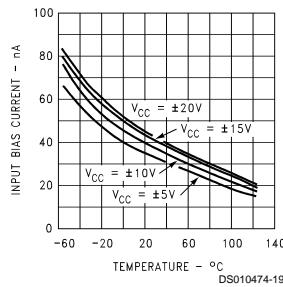
**Untrimmed Input Offset Voltage vs Temperature**



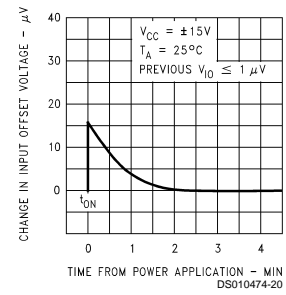
**Input Offset Current vs Temperature**



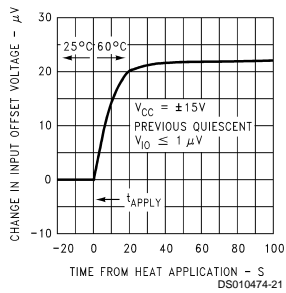
**Input Bias Current vs Temperature**



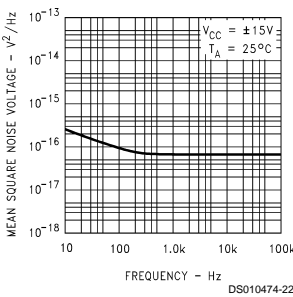
**Stabilization Time of Input Offset Voltage from Power Turn-On**



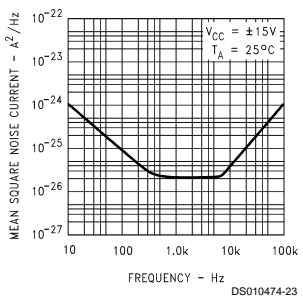
**Change in Input Offset Voltage Due to Thermal Shock vs Time**



**Input Noise Voltage vs Frequency**

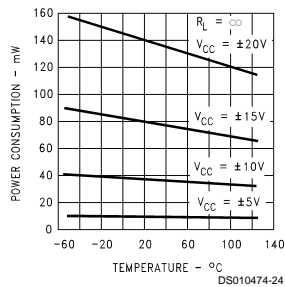


**Input Noise Current vs Frequency**

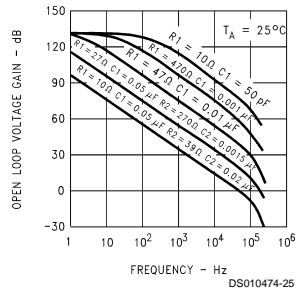


## Typical Performance Characteristics (Continued)

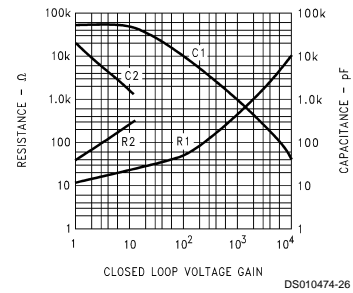
**Power Consumption vs Temperature**



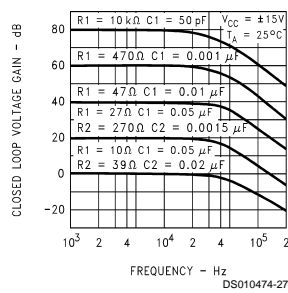
**Open Loop Frequency Response for Values of Compensation (Note 6)**



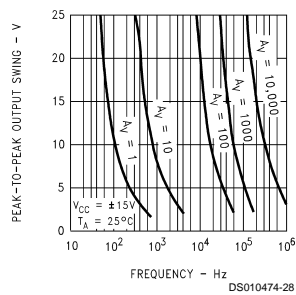
**Values for Suggested Compensation Networks vs Various Close Loop Voltage Gains**



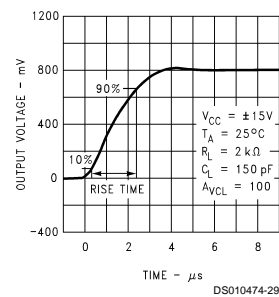
**Frequency Response for Various Close Loop Gain (Note 6)**



**Output Voltage Swing vs Frequency (Note 6)**

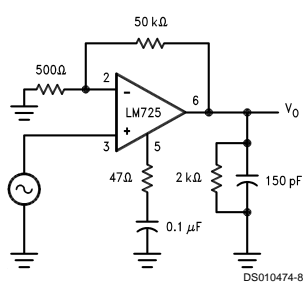


**Transient Response**



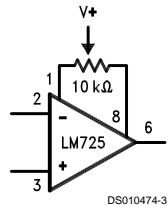
**Note 6:** Performance is shown using recommended compensation networks.

**Transient Response Test Circuit**

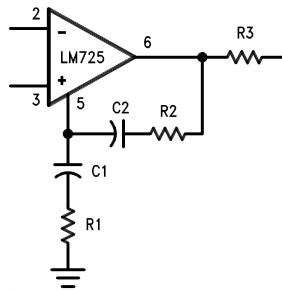


## Auxiliary Circuits

Voltage Offset Null Circuit



Frequency Compensation Circuit

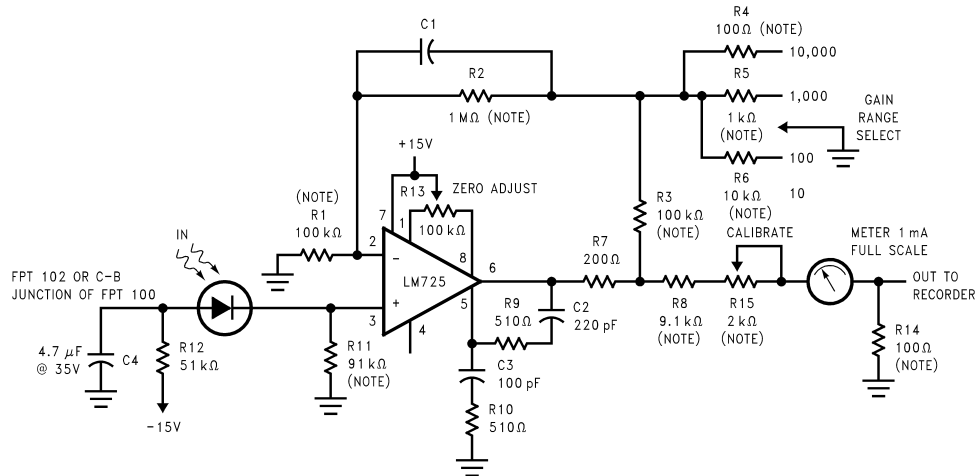


## Compensation Component Values

$A_V$	$R_1$ ( $\Omega$ )	$C_1$ ( $\mu\text{F}$ )	$R_2$ ( $\Omega$ )	$C_2$ ( $\mu\text{F}$ )
10,000	10k	50 pF		
1,000	470	0.001		
100	47	0.01		
10	27	0.05	270	0.0015
1	10	0.05	39	0.02

## Typical Applications

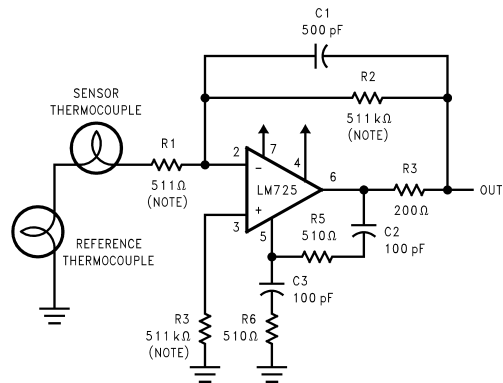
### Photodiode Amplifier



DS010474-9

DC Gains = 10,000; 1,000; 100; and 10  
Bandwidth = Determined by value of C1

### Thermocouple Amplifier



DS010474-10

$$\frac{R2}{R5} = \frac{R6}{R7} \text{ for best CMR}$$

$$R1 = R4$$

$$R2 = R5$$

$$\text{Gain} = \frac{R6}{R2} + \left( \frac{2R1}{R3} \right)$$

DC Gain = 1000

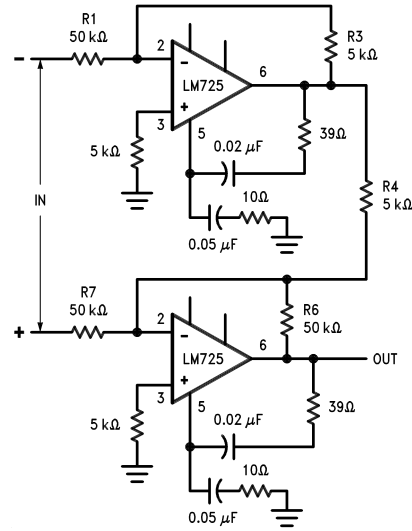
Bandwidth = DC to 540 Hz

Equivalent Input Noise = 0.24  $\mu\text{V}_{\text{rms}}$

**Note:** Indicates  $\pm 1\%$  metal film resistors recommended for temperature stability.

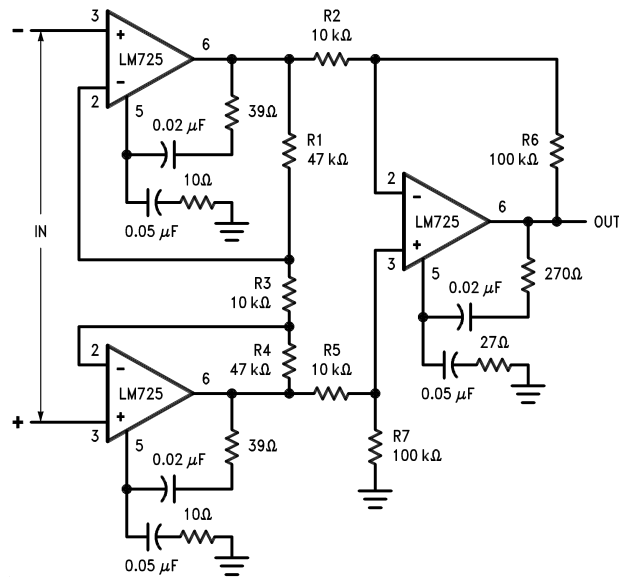
## Typical Applications (Continued)

### ±100V Common Mode Range Differential Amplifier



DS010474-11

### Instrumentation Amplifier with High Common Mode Rejection



DS010474-12

$$\frac{R1}{R6} = \frac{R3}{R4} \text{ for best CMRR}$$

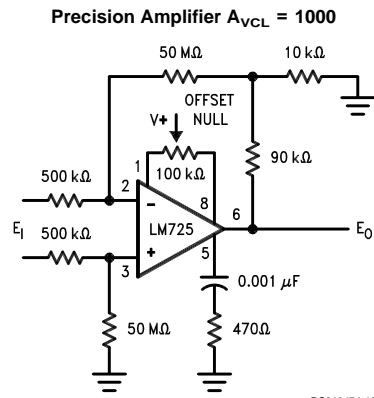
$$R3 = R4$$

$$R1 = R6 = 10 R3$$

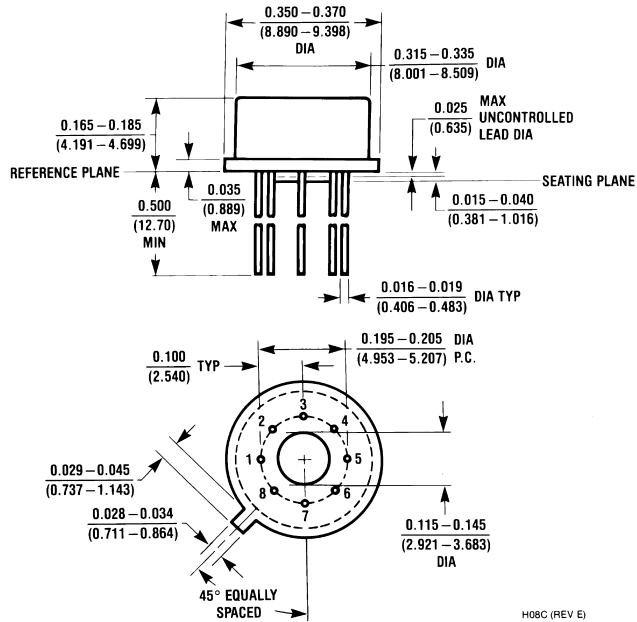
$$\text{Gain} = \frac{R6}{R7}$$



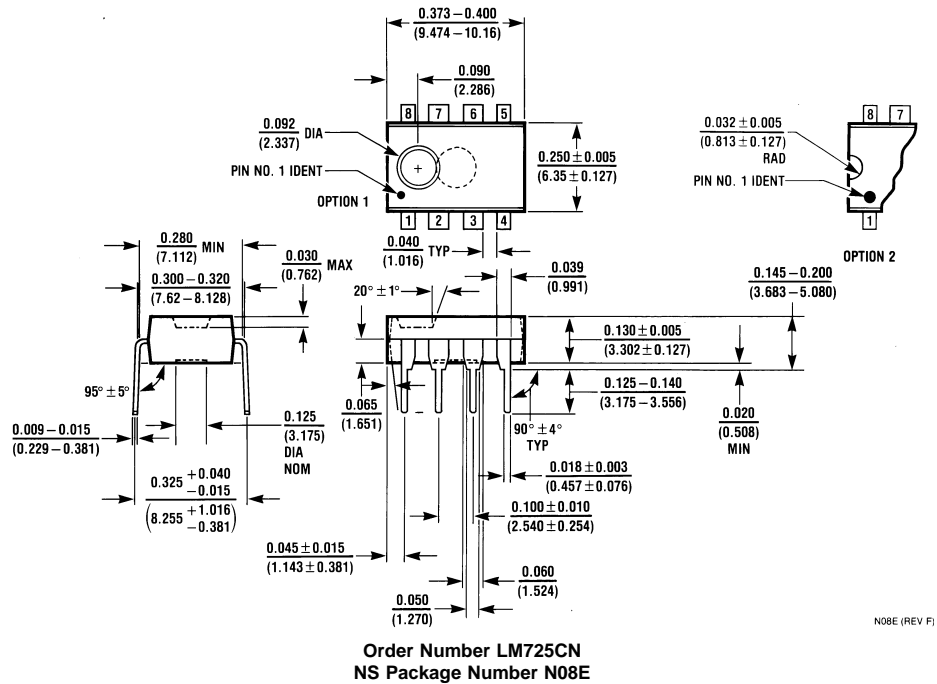
## Typical Applications (Continued)



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



Order Number LM725H/883, LM725CH or LM725AH/883  
NS Package Number H08C



Order Number LM725CN  
NS Package Number N08E

## Notes

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