

LM725 Operational Amplifier

General Description

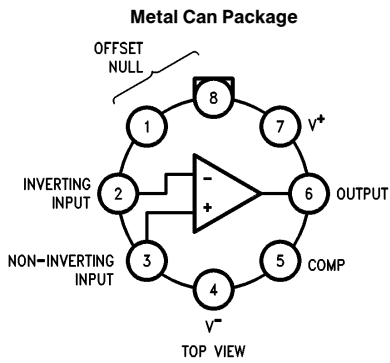
The LM725/LM725A/LM725C are operational amplifiers featuring superior performance in applications where low noise, low drift, and accurate closed-loop gain are required. With high common mode rejection and offset null capability, it is especially suited for low level instrumentation applications over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

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

Features

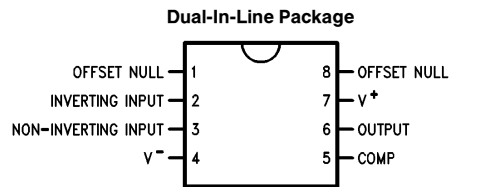
- High open loop gain 3,000,000
- Low input voltage drift $0.6 \mu\text{V}/^{\circ}\text{C}$
- High common mode rejection 120 dB
- Low input noise current $0.15 \text{ pA}/\sqrt{\text{Hz}}$
- Low input offset current 2 nA
- High input voltage range $\pm 14\text{V}$
- Wide power supply range $\pm 3\text{V}$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

Connection Diagrams and Ordering Information



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

TL/H/10474-1



Order Number **LM725CN**
See NS Package Number **N08E**

TL/H/10474-2

Absolute Maximum Ratings

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 1)	500 mW
Differential Input Voltage	±5V
Input Voltage (Note 2)	±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 3)

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			$\text{nV}/\sqrt{\text{Hz}}$ $\text{nV}/\sqrt{\text{Hz}}$ $\text{nV}/\sqrt{\text{Hz}}$
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			$\text{pA}/\sqrt{\text{Hz}}$ $\text{pA}/\sqrt{\text{Hz}}$ $\text{pA}/\sqrt{\text{Hz}}$
Input Resistance	$T_A = 25^\circ\text{C}$		1.5		1.5			1.5			M Ω
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 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 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 nA

Electrical Characteristics (Note 3) (Continued)

Parameter	Conditions	LM725A			LM725			LM725C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Large Signal Voltage Gain	$R_L \geq 2\text{ k}\Omega$ $T_A = T_{MAX}$	1,000,000			1,000,000			125,000			V/V
	$R_L \geq 2\text{ k}\Omega$ $T_A = T_{MIN}$	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	$R_L \geq 2\text{ k}\Omega$	± 12			± 10			± 10			V

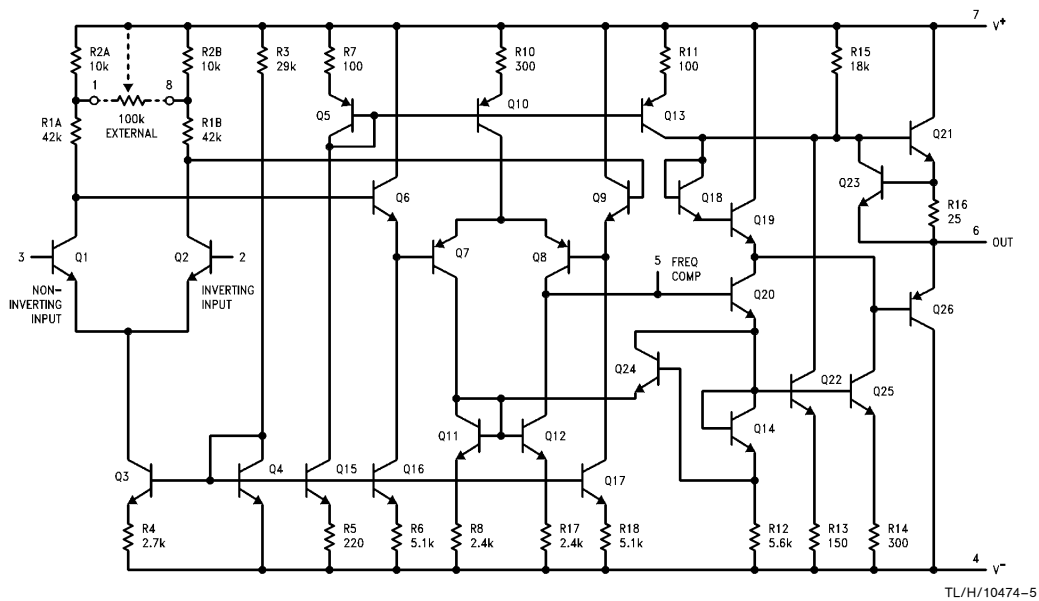
Note 1: Derate at 150°C/W for operation at ambient temperatures above 75°C.

Note 2: For supply voltages less than $\pm 22\text{V}$, the absolute maximum input voltage is equal to the supply voltage.

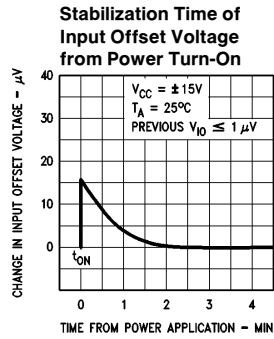
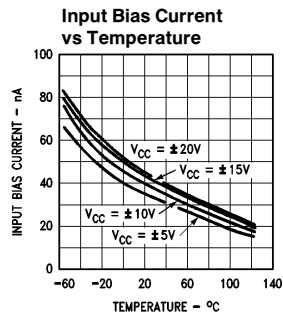
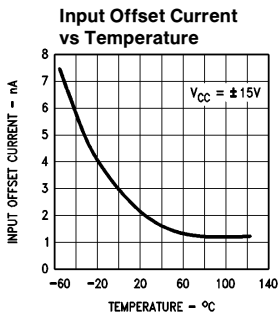
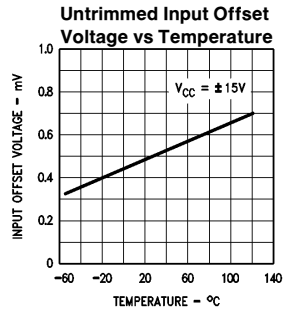
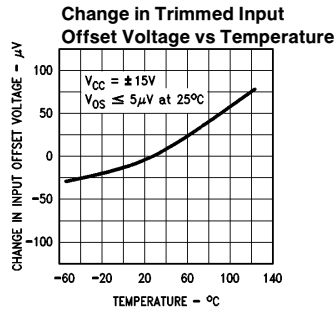
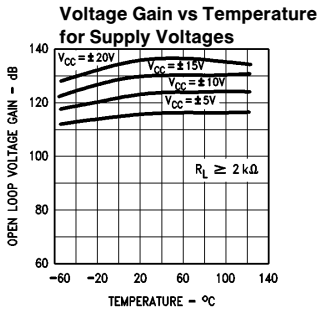
Note 3: These specifications apply for $V_S = \pm 15\text{V}$ unless otherwise specified.

Note 4: For Military electrical specifications RETS725AX are available for LM725AH and RETS725X are available for LM725H.

Schematic Diagram

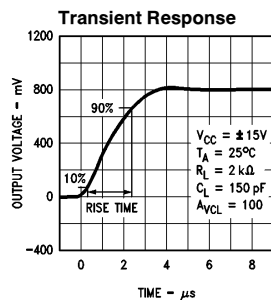
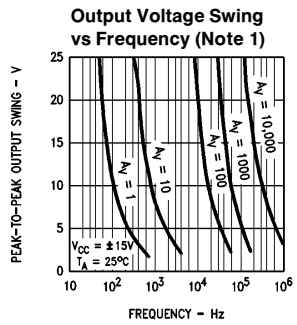
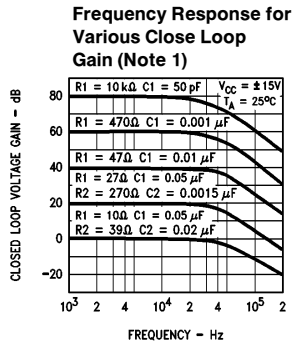
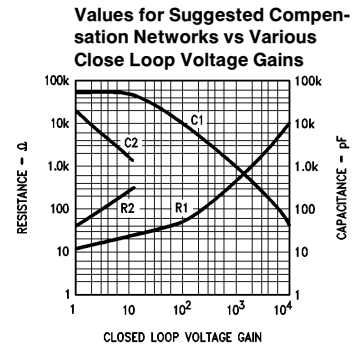
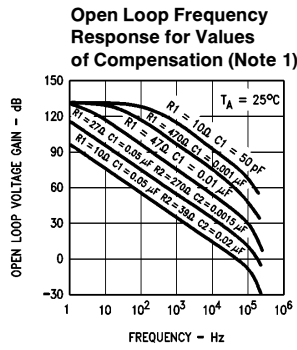
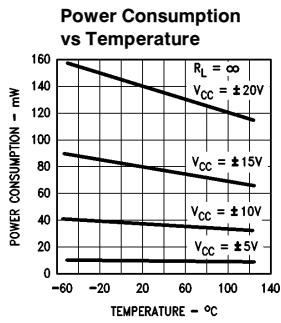
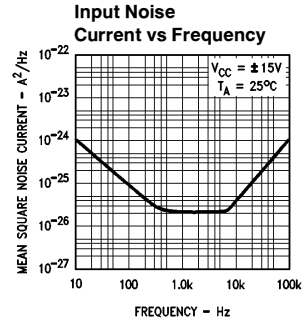
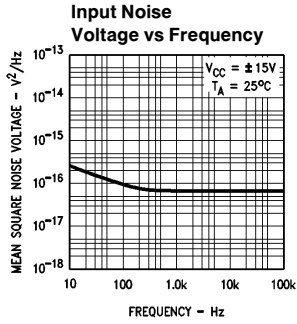
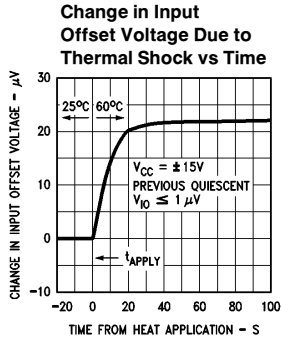


Typical Performance Characteristics



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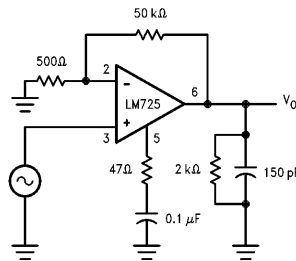
Typical Performance Characteristics (Continued)



Note 1: Performance is shown using recommended compensation networks.

TL/H/10474-7

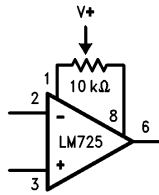
Transient Response Test Circuit



TL/H/10474-8

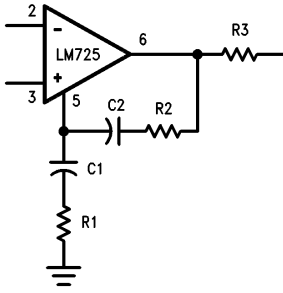
Auxiliary Circuits

Voltage Offset Null Circuit



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Frequency Compensation Circuit



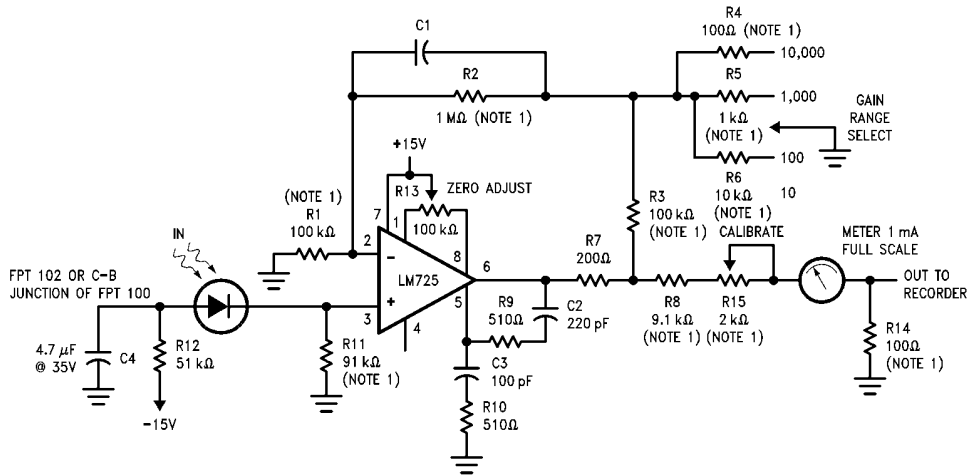
TL/H/10474-4

Compensation Component Values

A_V	R_1 (Ω)	C_1 (μF)	R_2 (Ω)	C_2 (μF)
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

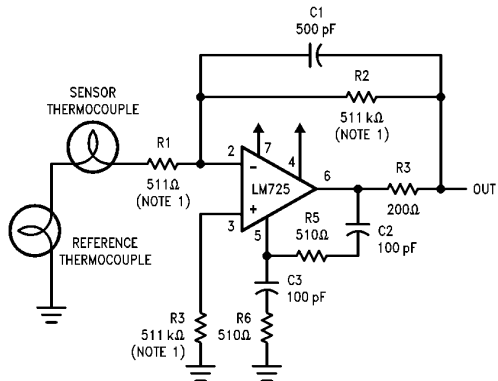
Photodiode Amplifier



TL/H/10474-9

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

Thermocouple Amplifier



TL/H/10474-10

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

$$R1 = R4$$

$$R2 = R5$$

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

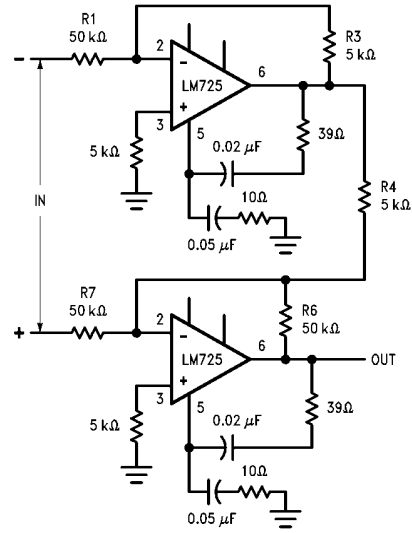
DC Gain = 1000

Bandwidth = DC to 540 Hz

Equivalent Input Noise = 0.24 μV_{rms}

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

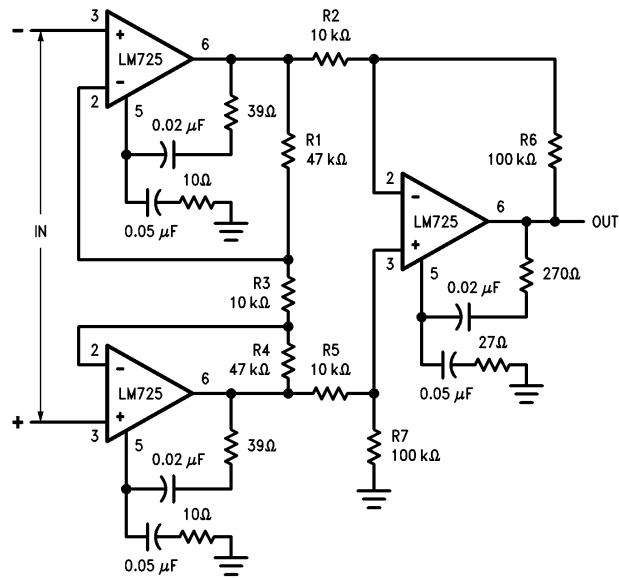
$\pm 100\text{V}$ Common Mode Range Differential Amplifier



TL/H/10474-11

Typical Applications (Continued)

Instrumentation Amplifier with High Common Mode Rejection



TL/H/10474-12

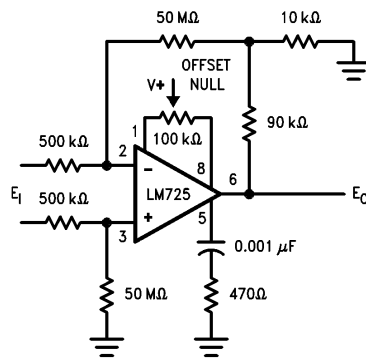
$$\frac{R1}{R6} = \frac{R3}{R4} \text{ for best CMRR}$$

$$R3 = R4$$

$$R1 = R6 = 10 R3$$

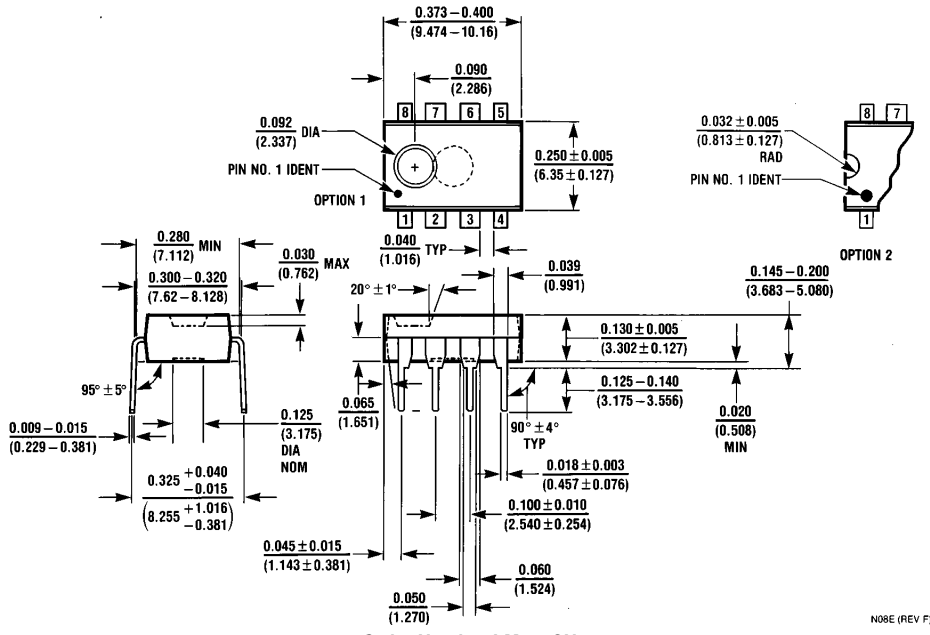
$$\text{Gain} = \frac{R6}{R7}$$

Precision Amplifier $A_{VCL} = 1000$



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Physical Dimensions inches (millimeters) (Continued)



Order Number LM725CN
NS Package Number N08E

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