LM725 Operational Amplifier

Check for Samples: LM725

FEATURES

- **High open loop gain 3,000,000**
- **Low input voltage drift 0.6 μV/°C**
- **High common mode rejection 120 dB**
- **Low input noise current 0.15 pA/√Hz**
- **Low input offset current 2 nA**
- **High input voltage range ±14V**
- **Wide power supply range ±3V to ±22V**
- **Offset null capability**
- **Output short circuit protection**

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°C temperature range. The LM725C has slightly relaxed specifications and has its performance guaranteed over a 0°C to 70°C temperature range.

Connection Diagram

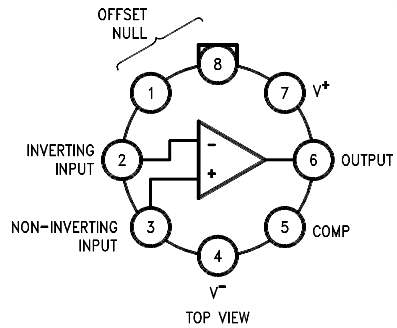


Figure 1. Metal Can Package

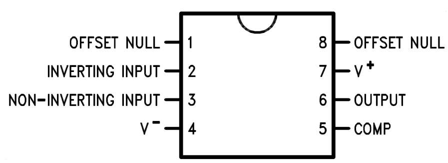


Figure 2. Dual-In-Line Package

Typical Applications

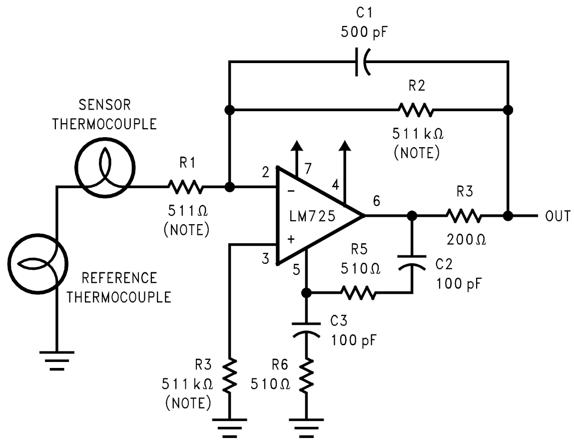


Figure 3. Thermocouple Amplifier

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings (1)

Supply Voltage	±22V
Internal Power Dissipation (2)	500 mW
Differential Input Voltage	±5V
Input Voltage (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

(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.
(2) Derate at 150°C/W for operation at ambient temperatures above 75°C.
(3) For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.

Electrical Characteristics (1)

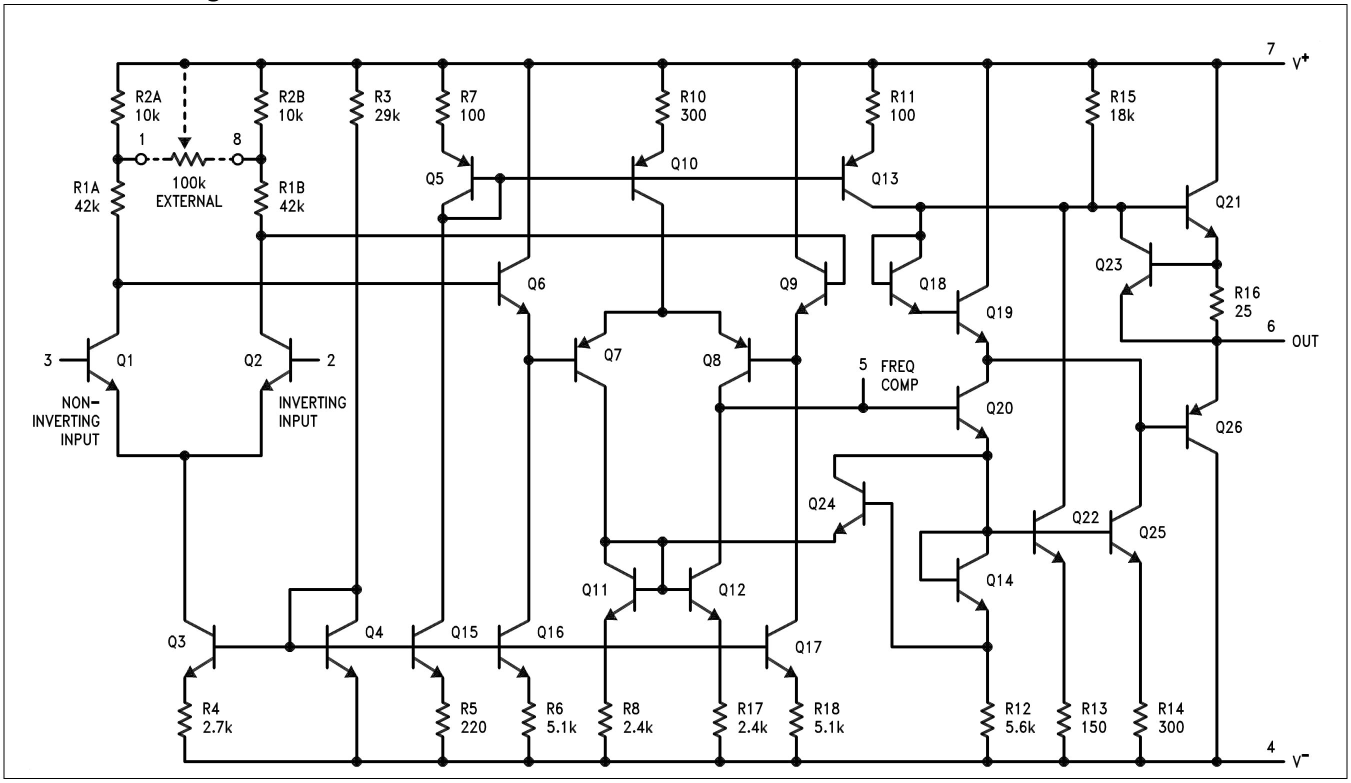
Parameter	Conditions	LM725A			LM725			LM725C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	T_A = 25°C,			0.5		0.5	1.0		0.5	2.5	mV
(Without External Trim)	R_S ≤ 10 kΩ										
Input Offset Current	T_A = 25°C		2.0	5.0		2.0	20		2.0	35	nA
Input Bias Current	T_A = 25°C		42	80		42	100		42	125	nA
Input Noise Voltage	T_A = 25°C										
	f_o = 10 Hz		15			15			15		nV/√Hz
	f_o = 100 Hz		9.0			9.0			9.0		nV/√Hz
	f_o = 1 kHz		8.0			8.0			8.0		nV/√Hz
Input Noise Current	T_A = 25°C										
	f_o = 10 Hz		1.0			1.0			1.0		pA/√Hz
	f_o = 100 Hz		0.3			0.3			0.3		pA/√Hz
	f_o = 1 kHz		0.15			0.15			0.15		pA/√Hz
Input Resistance	T_A = 25°C		1.5			1.5			1.5		MΩ
Input Voltage Range	T_A = 25°C	±13.5	±14		±13.5	±14		±13.5	±14		V
Large Signal Voltage Gain	T_A = 25°C,										
	R_L ≥ 2 kΩ,	1000	3000		1000	3000		250	3000		V/mV
	V_{OUT} = ±10V										
Common-Mode	T_A = 25°C,	120			110	120		94	120		dB
Rejection Ratio	R_S ≤ 10 kΩ										
Power Supply	T_A = 25°C,		2.0	5.0		2.0	10		2.0	35	μV/V
Rejection Ratio	R_S ≤ 10 kΩ										
Output Voltage Swing	T_A = 25°C,										
	R_L ≥ 10 kΩ	±12.5	±13.5		±12	±13.5		±12	±13.5		V
	R_L ≥ 2 kΩ	±12.0	±13.5		±10	±13.5		±10	±13.5		V
Power Consumption	T_A = 25°C		80	105		80	105		80	150	mW
Input Offset Voltage	R_S ≤ 10 kΩ			0.7			1.5			3.5	mV
(Without External Trim)											
Average Input Offset	R_S = 50Ω										
Voltage Drift				2.0		2.0	5.0		2.0		μV/°C
(Without External Trim)											
Average Input Offset	R_S = 50Ω										
Voltage Drift			0.6	1.0		0.6			0.6		μV/°C
(With External Trim)											
Input Offset Current	T_A = T_{MAX}		1.2	4.0		1.2	20		1.2	35	nA
	T_A = T_{MIN}		7.5	18.0		7.5	40		4.0	50	nA
Average Input Offset			35	90		35	150		10		pA/°C
Current Drift											
Input Bias Current	T_A = T_{MAX}		20	70		20	100			125	nA
	T_A = T_{MIN}		80	180		80	200			250	nA
Large Signal Voltage Gain	R_L ≥ 2 kΩ										
	T_A = T_{MAX}	1,000,000			1,000,000			125,000			V/V
	R_L ≥ 2 kΩ										
	T_A = T_{MIN}	500,000			250,000			125,000			V/V
Common-Mode	R_S ≤ 10 kΩ	110			100				115		dB

(1) These specifications apply for V_S = ±15V unless otherwise specified.

Electrical Characteristics (1) (continued)

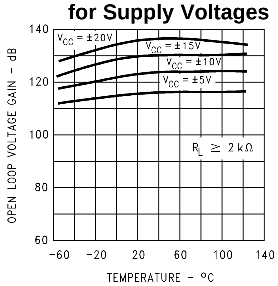
Parameter	Conditions	LM725A			LM725			LM725C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Rejection Ratio											
Power Supply	$R_S \leq 10\ k\Omega$			8.0			20		20		μV/V
Rejection Ratio											
Output Voltage Swing	$R_L \geq 2\ k\Omega$	±12			±10			±10			V

Schematic Diagram

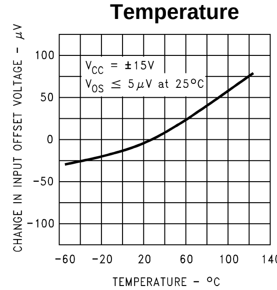


Typical Performance Characteristics

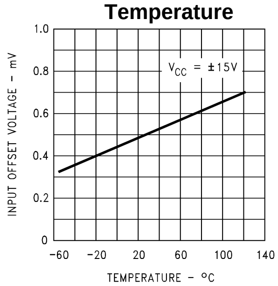
Voltage Gain vs Temperature for Supply Voltages



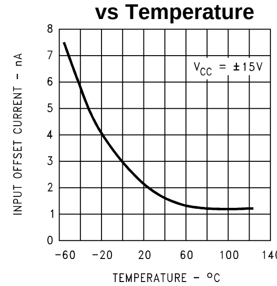
Change in Trimmed Input Offset Voltage vs Temperature



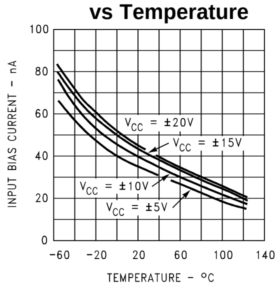
Untrimmed Input Offset Voltage vs Temperature



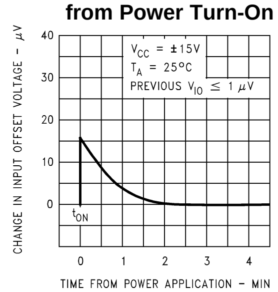
Input Offset Current vs Temperature



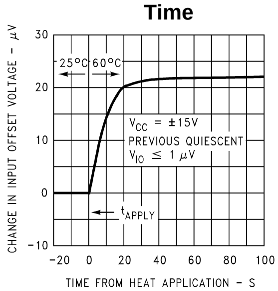
Input Bias Current vs Temperature



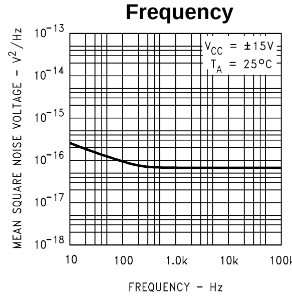
Stabilization Time of Input Offset Voltage from Power Turn-On



Change in Input Offset Voltage Due to Thermal Shock vs Time

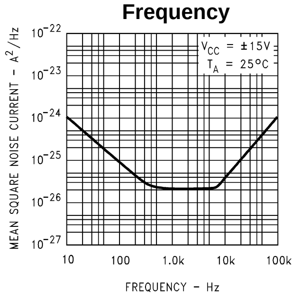


Input Noise Voltage vs Frequency

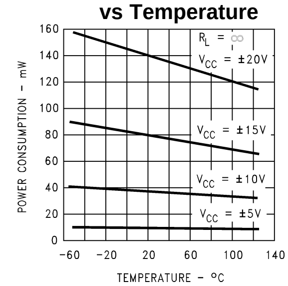


Typical Performance Characteristics (continued)

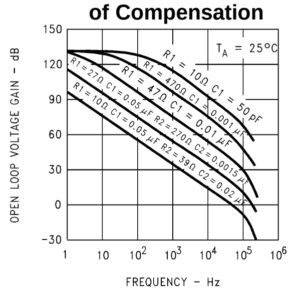
Input Noise Current vs Frequency



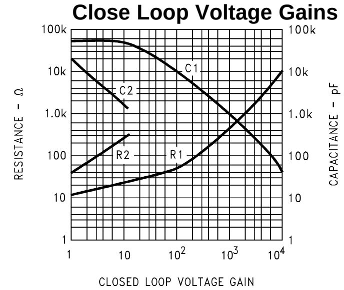
Power Consumption vs Temperature



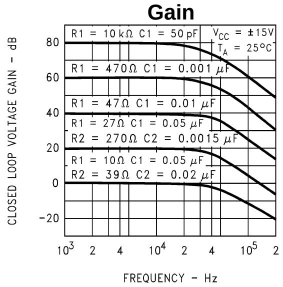
Open Loop Frequency Response for Values of Compensation



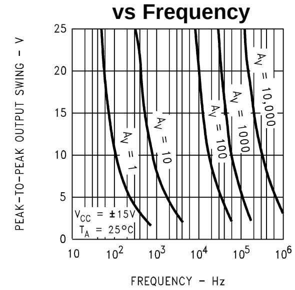
Values for Suggested Compensation Networks vs Various Close Loop Voltage Gains



Frequency Response for Various Close Loop Gain

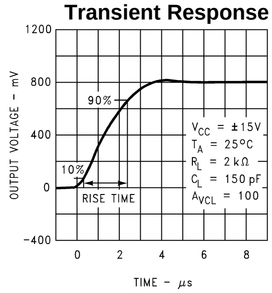


Output Voltage Swing vs Frequency

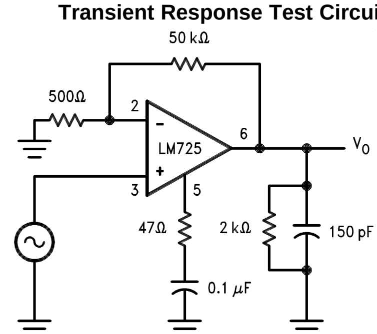


Performance is shown using recommended compensation networks.

Transient Response



Transient Response Test Circuit



Auxiliary Circuits

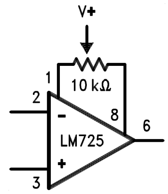


Figure 4. Voltage Offset Null Circuit

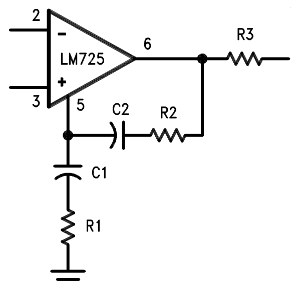
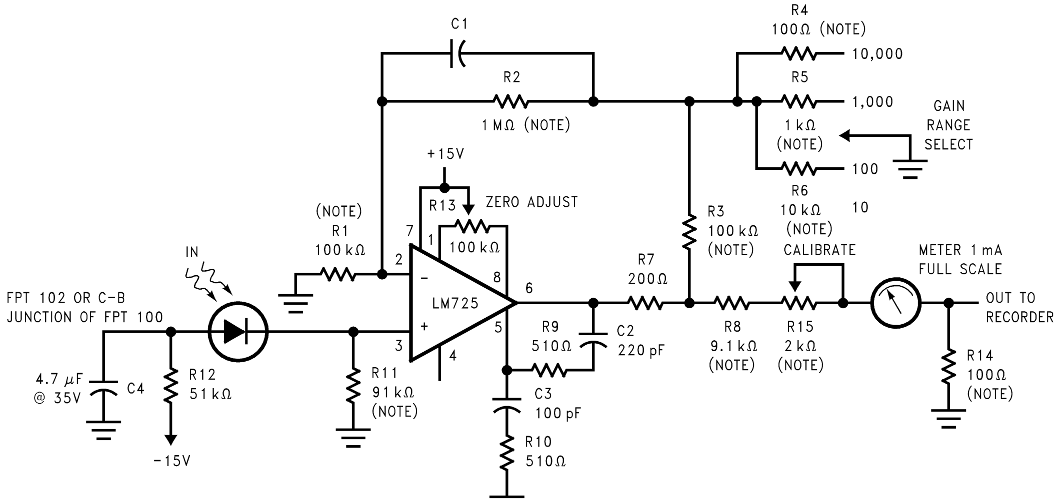


Figure 5. Frequency Compensation Circuit

Table 1. Compensation Component Values

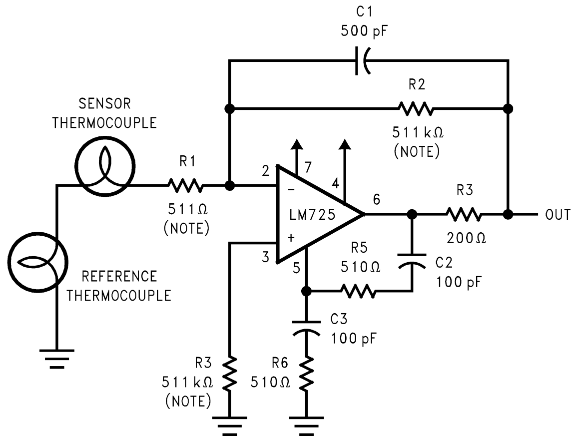
A_V	R_1 (Ω)	C_1 (µF)	R_2 (Ω)	C_2 (µF)
10,000	10k	50 pF		
1,000	470	0.001		
100	47	0.01		
10	27	0.05	270	0.0015
1	10	0.05	39	0.02

Typical Applications



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

Figure 6. Photodiode Amplifier



$\frac{R2}{R5} = \frac{R6}{R7}$ 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}

Indicates ±1% metal film resistors recommended for temperature stability.

Figure 7. Thermocouple Amplifier

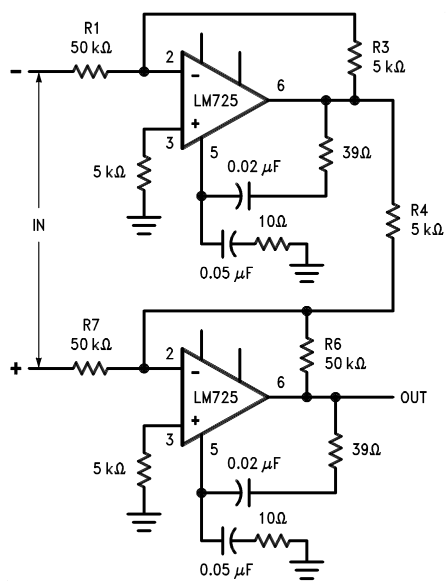
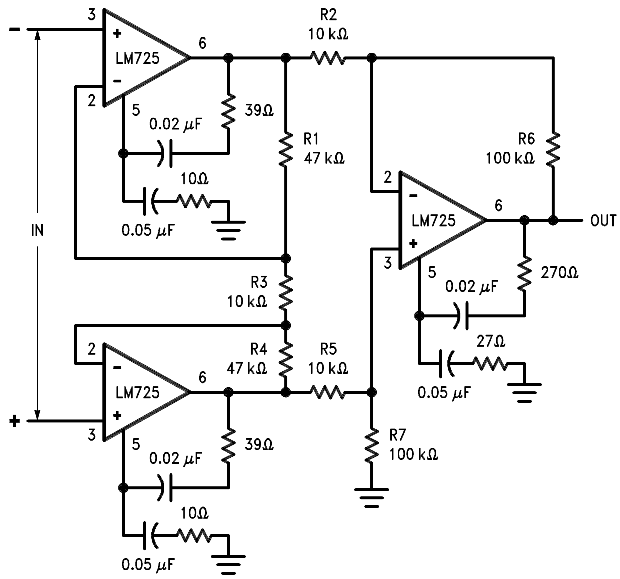


Figure 8. ±100V Common Mode Range Differential Amplifier



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

$R3 = R4$

$R1 = R6 = 10\ R3$

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

Figure 9. Instrumentation Amplifier with High Common Mode Rejection

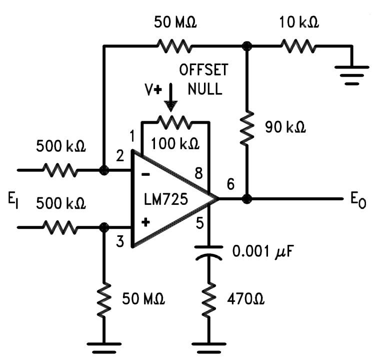


Figure 10. Precision Amplifier A_{VCL} = 1000

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