LM725 Operational Amplifier

Check for Samples: LM725

FEATURES

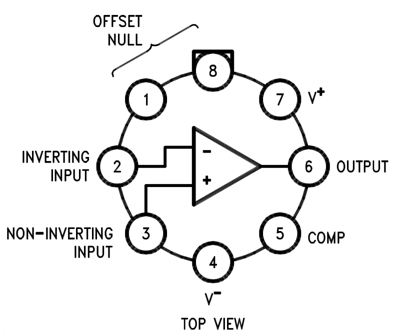
- **High Open Loop Gain: 3,000,000**
- **Low Input Voltage Drift 0.6 μV/°C**
- **High Common Mode Rejection 120 dB**
- **Low Input Noise Current 0.15 pA/√Hz**
- **Low Input Offset Current 2 nA**
- **High Input Voltage Range ±14V**
- **Wide Power Supply Range ±3V to ±22V**
- **Offset Null Capability**
- **Output Short Circuit Protection**

DESCRIPTION

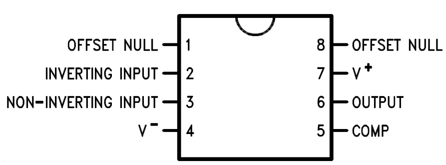
The LM725/LM725A/LM725C are operational amplifiers featuring superior performance in applications where low noise, low drift, and accurate closed-loop gain are required. With high common mode rejection and offset null capability, it is especially suited for low level instrumentation applications over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



Metal Can Package



Dual-In-Line Package

TYPICAL APPLICATIONS

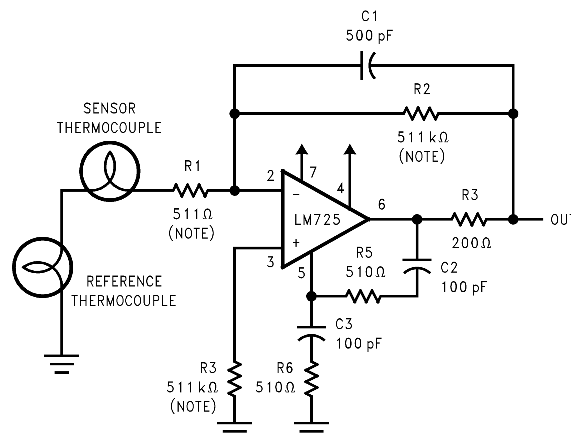


Figure 1. Thermocouple Amplifier

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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)

If Military/Aerospace specified devices are required, contact the Texas Instruments Semiconductor Sales Office/ Distributors for availability and specifications. (2)

Supply Voltage	±22V
Internal Power Dissipation (3)	500 mW
Differential Input Voltage	±5V
Input Voltage (4)	±22V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 Sec.)	260°C
Maximum Junction Temperature	150°C
Operating Temperature Range ($T_{A(MIN)}$ to $T_{A(MAX)}$)	
LM725	−55°C to +125°C
LM725A	−55°C to +125°C
LM725C	0°C to +70°C

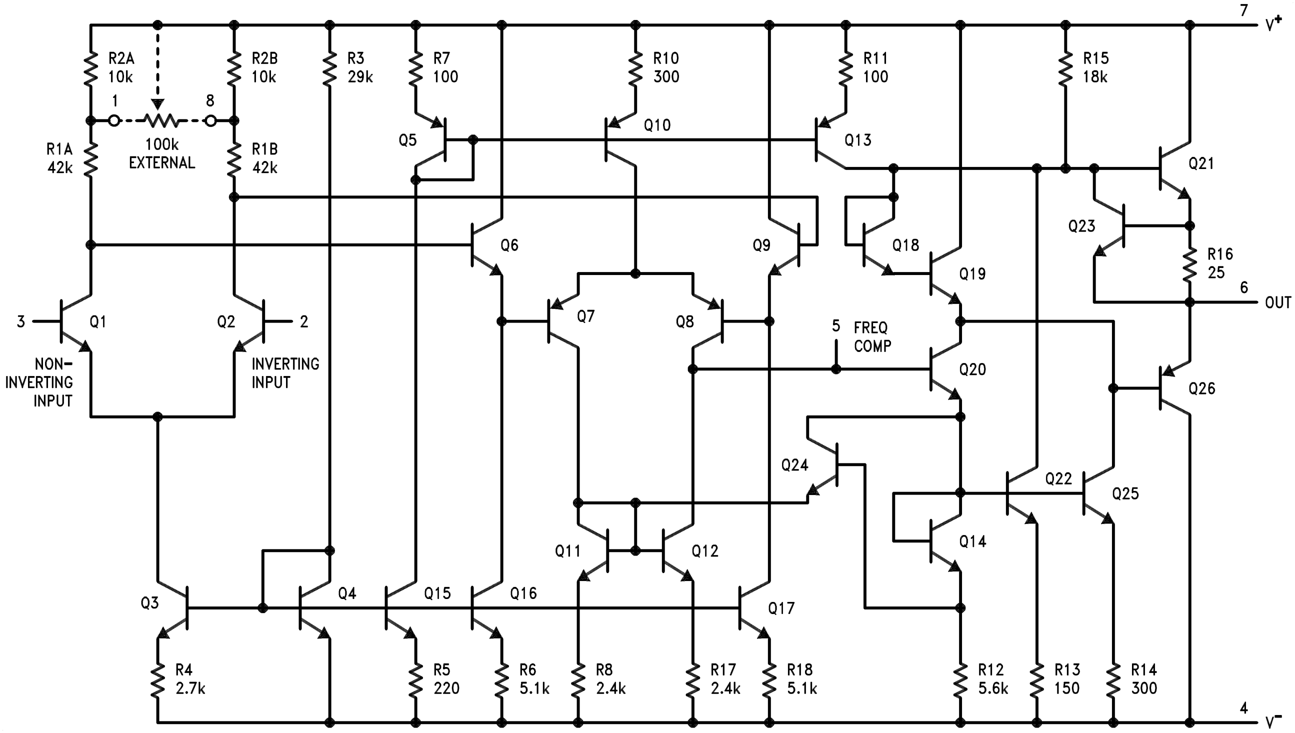
(1) "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but **do not** guarantee specific performance limits.
(2) For Military electrical specifications RETS725AX are available for LM725AH and RETS725X are available for LM725H.
(3) Derate at 150°C/W for operation at ambient temperatures above 75°C.
(4) 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 (Without External Trim)	T_A = 25°C, R_S ≤ 10 kΩ			0.5		0.5	1.0		0.5	2.5	mV
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, V_{OUT} = ±10V	1000	3000		1000	3000		250	3000		V/mV
Common-Mode Rejection Ratio	T_A = 25°C, R_S ≤ 10 kΩ	120			110	120		94	120		dB
Power Supply Rejection Ratio	T_A = 25°C, R_S ≤ 10 kΩ		2.0	5.0		2.0	10		2.0	35	μV/V
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 (Without External Trim)	R_S ≤ 10 kΩ			0.7			1.5			3.5	mV
Average Input Offset Voltage Drift (Without External Trim)	R_S = 50Ω			2.0		2.0	5.0		2.0		μV/°C
Average Input Offset Voltage Drift (With External Trim)	R_S = 50Ω		0.6	1.0		0.6			0.6		μV/°C
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 Current Drift			35	90		35	150		10		pA/°C
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 Rejection Ratio	R_S ≤ 10 kΩ	110			100				115		dB
Power Supply Rejection Ratio	R_S ≤ 10 kΩ			8.0			20		20		μV/V
Output Voltage Swing	R_L ≥ 2 kΩ	±12			±10			±10			V

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

SCHEMATIC DIAGRAM



TYPICAL PERFORMANCE CHARACTERISTICS

Voltage Gain vs Temperature for Supply Voltages

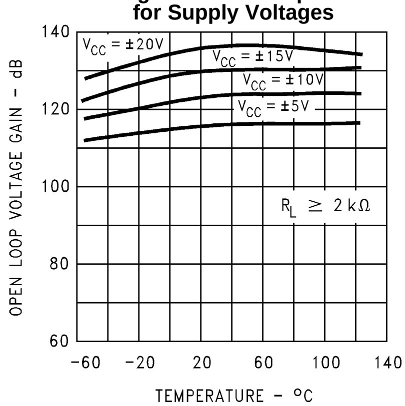


Figure 2.

Change in Trimmed Input Offset Voltage vs Temperature

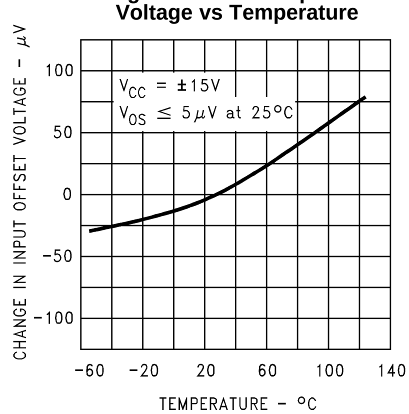


Figure 3.

Untrimmed Input Offset Voltage vs Temperature

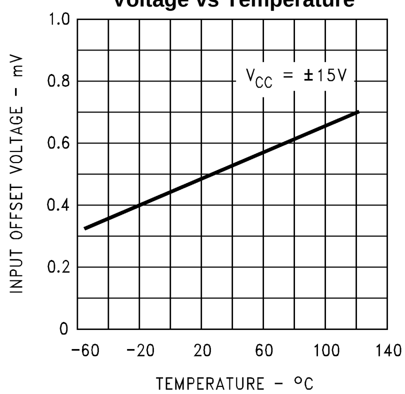


Figure 4.

Input Offset Current vs Temperature

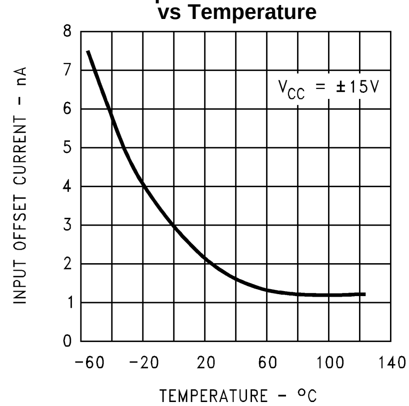


Figure 5.

Input Bias Current vs Temperature

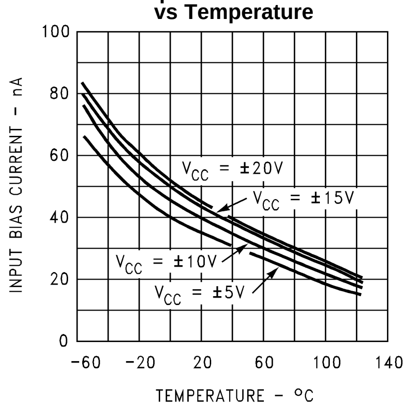


Figure 6.

Stabilization Time of Input Offset Voltage from Power Turn-On

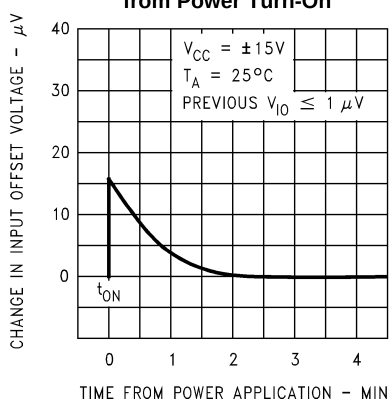


Figure 7.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Change in Input Offset Voltage Due to Thermal Shock vs Time

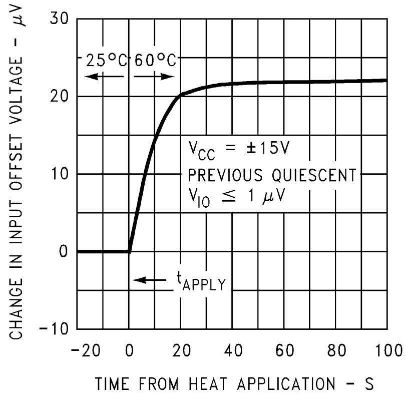


Figure 8.

Input Noise Voltage vs Frequency

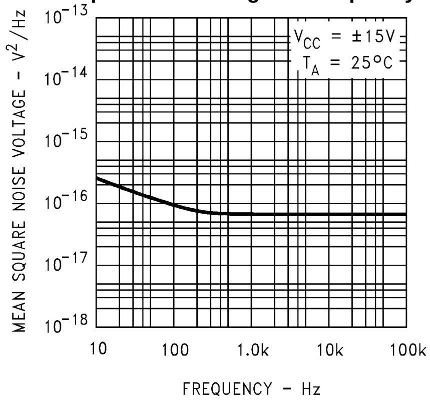


Figure 9.

Input Noise Current vs Frequency

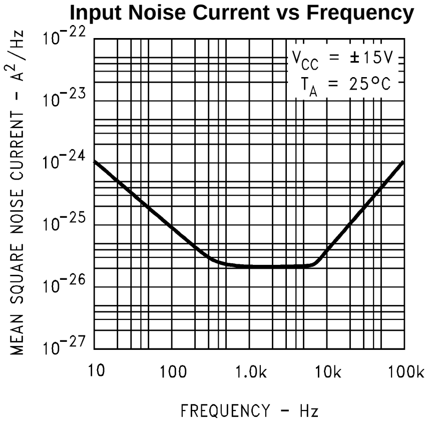


Figure 10.

Power Consumption vs Temperature

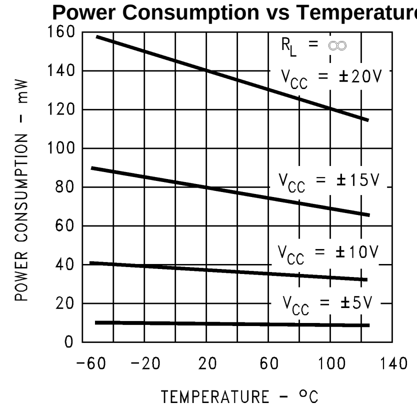


Figure 11.

Open Loop Frequency Response for Values of Compensation

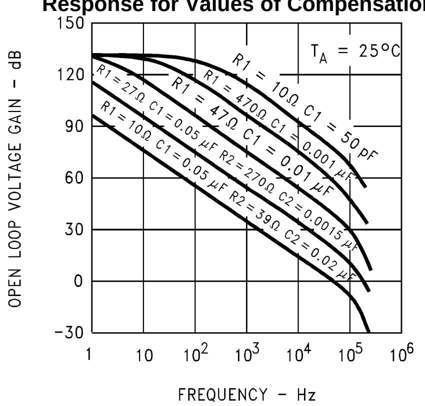


Figure 12.

Values for Suggested Compensation Networks vs Various Close Loop Voltage Gains

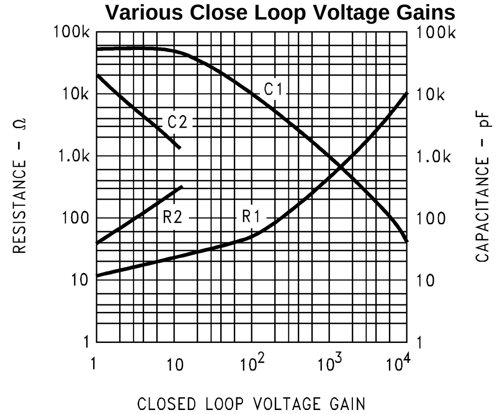
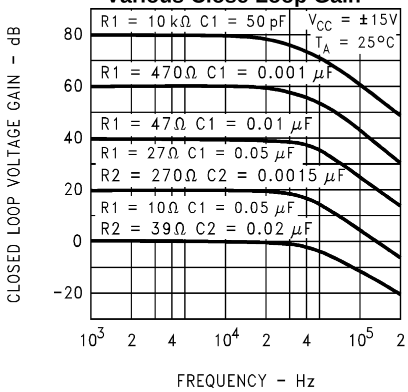


Figure 13.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

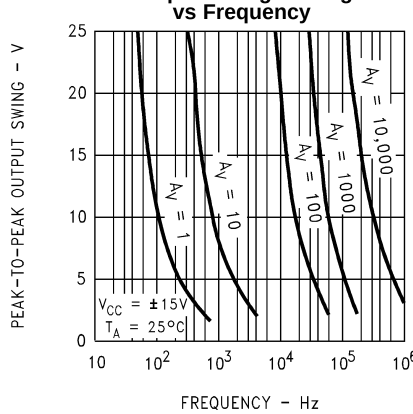
Frequency Response for Various Close Loop Gain



(1) Performance is shown using recommended compensation networks.

Figure 14.

Output Voltage Swing vs Frequency



(1) Performance is shown using recommended compensation networks.

Figure 15.

Transient Response

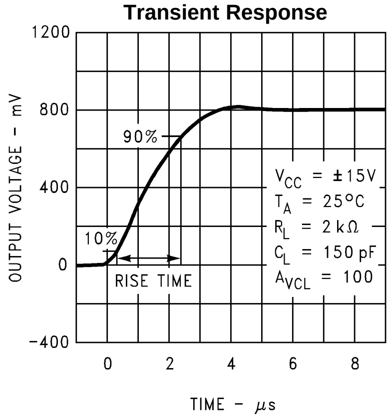


Figure 16.

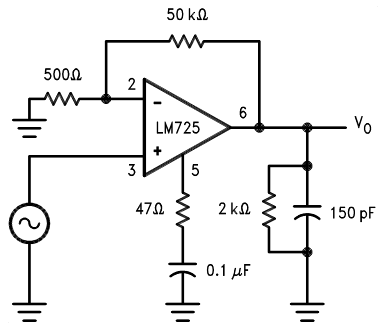


Figure 17. Transient Response Test Circuit

AUXILIARY CIRCUITS

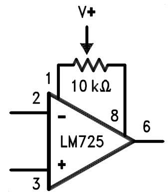


Figure 18. Voltage Offset Null Circuit

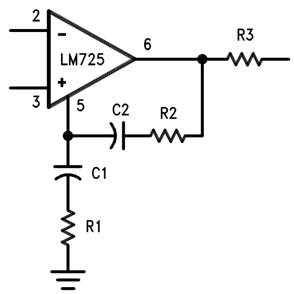
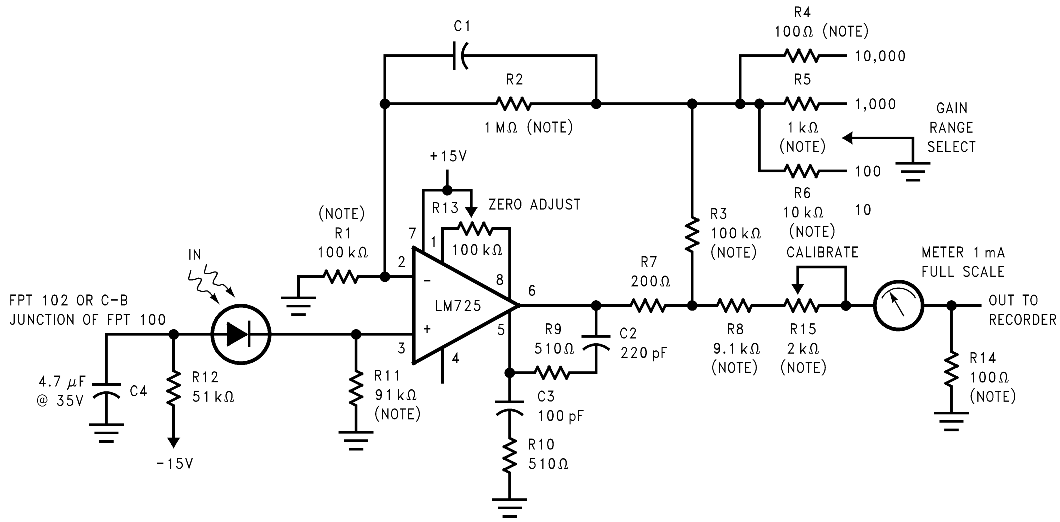


Figure 19. Frequency Compensation Circuit

Table 1. Compensation Component Values

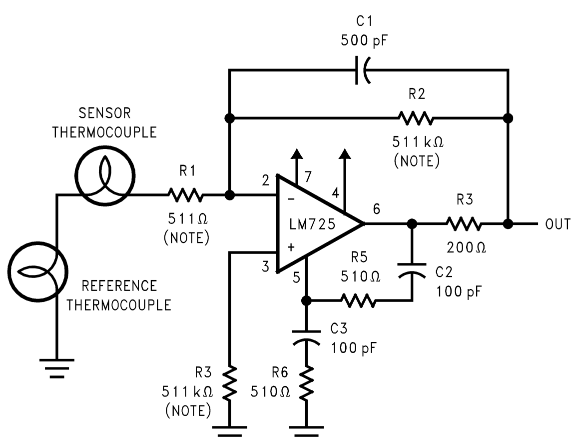
A_V	R_1 (Ω)	C_1 (μF)	R_2 (Ω)	C_2 (μF)
10,000	10k	50 pF		
1,000	470	0.001		
100	47	0.01		
10	27	0.05	270	0.0015
1	10	0.05	39	0.02

TYPICAL APPLICATIONS



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

Figure 20. 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 21. Thermocouple Amplifier

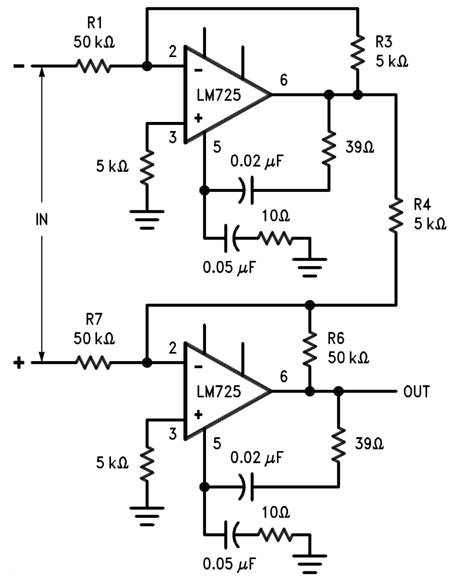
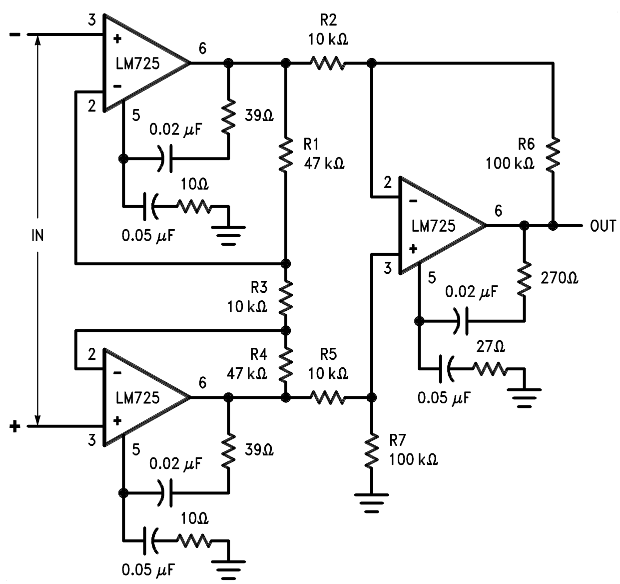


Figure 22. ±100V Common Mode Range Differential Amplifier



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

$R3 = R4$

$R1 = R6 = 10\ R3$

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

Figure 23. Instrumentation Amplifier with High Common Mode Rejection

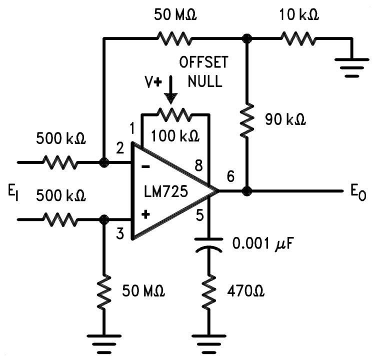


Figure 24. Precision Amplifier A_{VCL} = 1000

REVISION HISTORY

Changes from Revision C (April 2013) to Revision D	Page
• Changed layout of National Data Sheet to TI format	11

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