National Semiconductor

May 1998

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.

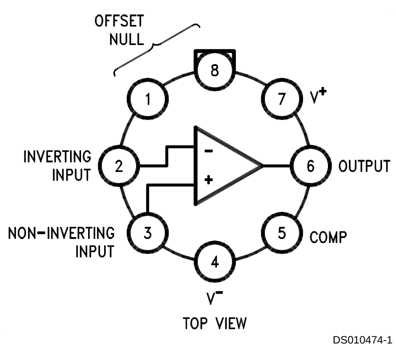
The LM725A has tightened electrical performance with higher input accuracy and like the LM725, is guaranteed over a −55˚C to +125˚C temperature range. The LM725C has slightly relaxed specifications and has its performance guaranteed over a 0˚C to 70˚C temperature range.

Features

- High open loop gain 3,000,000
- Low input voltage drift 0.6 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

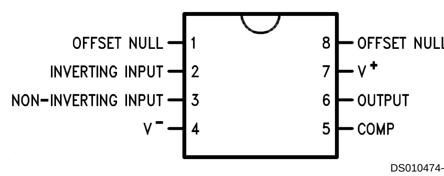
Connection Diagrams

Metal Can Package



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

Dual-In-Line Package



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˚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

Electrical Characteristics (Note 4) (Continued)

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

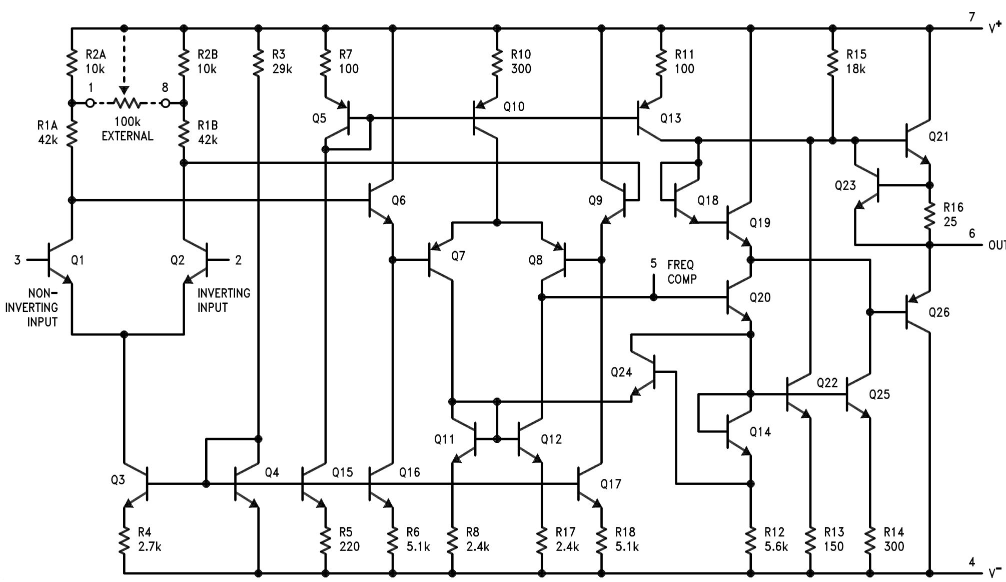
Note 2: Derate at 150˚C/W for operation at ambient temperatures above 75˚C.

Note 3: For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.

Note 4: These specifications apply for V_S = ±15V unless otherwise specified.

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

Schematic Diagram



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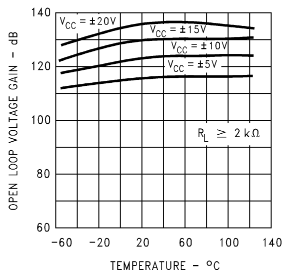
Typical Performance Characteristics

Voltage Gain vs Temperature for Supply Voltages



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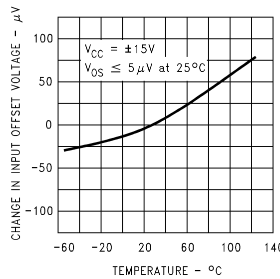
Change in Trimmed Input Offset Voltage vs Temperature



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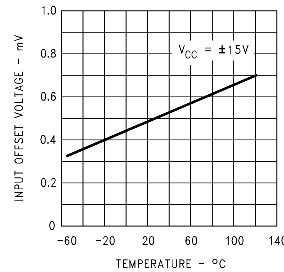
Untrimmed Input Offset Voltage vs Temperature



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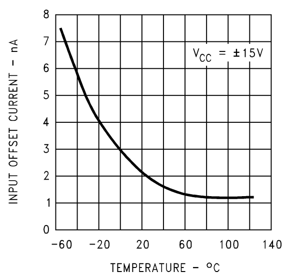
Input Offset Current vs Temperature



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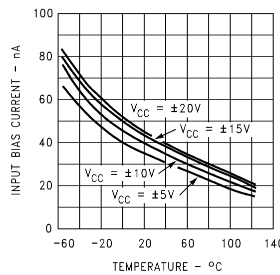
Input Bias Current vs Temperature



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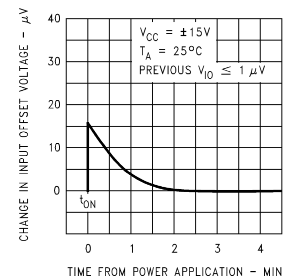
Stabilization Time of Input Offset Voltage from Power Turn-On



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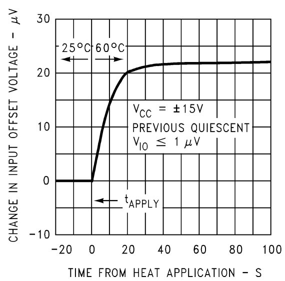
Change in Input Offset Voltage Due to Thermal Shock vs Time



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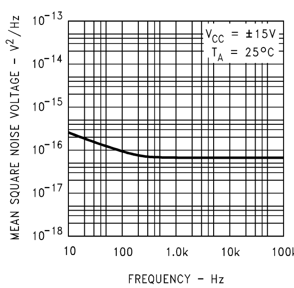
Input Noise Voltage vs Frequency



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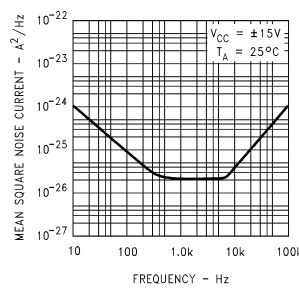
Input Noise Current vs Frequency



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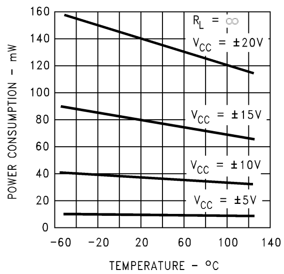
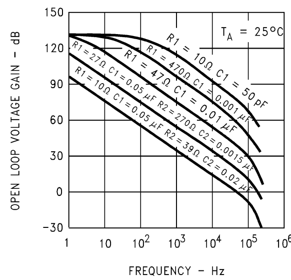
Typical Performance Characteristics (Continued)

Power Consumption vs Temperature



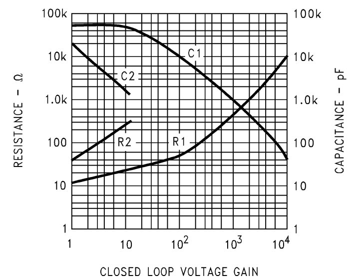
DS010474-24

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



DS010474-25

Values for Suggested Compensation Networks vs Various Close Loop Voltage Gains



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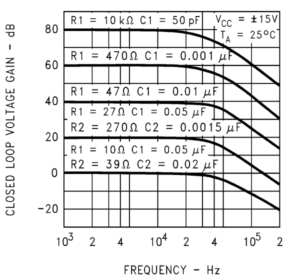
Frequency Response for Various Close Loop Gain (Note 6)



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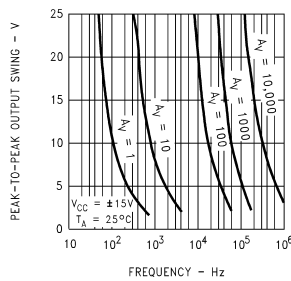
Output Voltage Swing vs Frequency (Note 6)



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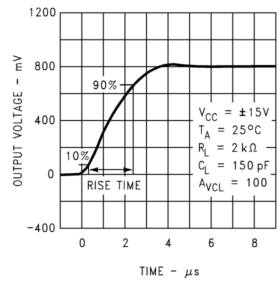
Transient Response



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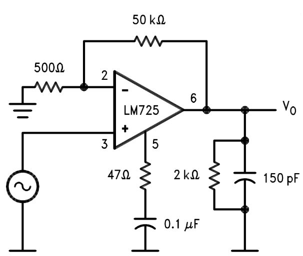
Note 6: Performance is shown using recommended compensation networks.

Transient Response Test Circuit



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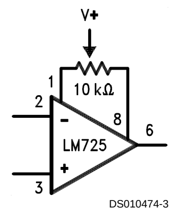
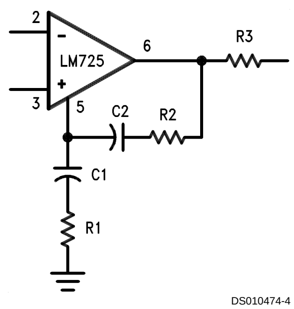
Auxiliary Circuits

Voltage Offset Null Circuit



Frequency Compensation Circuit

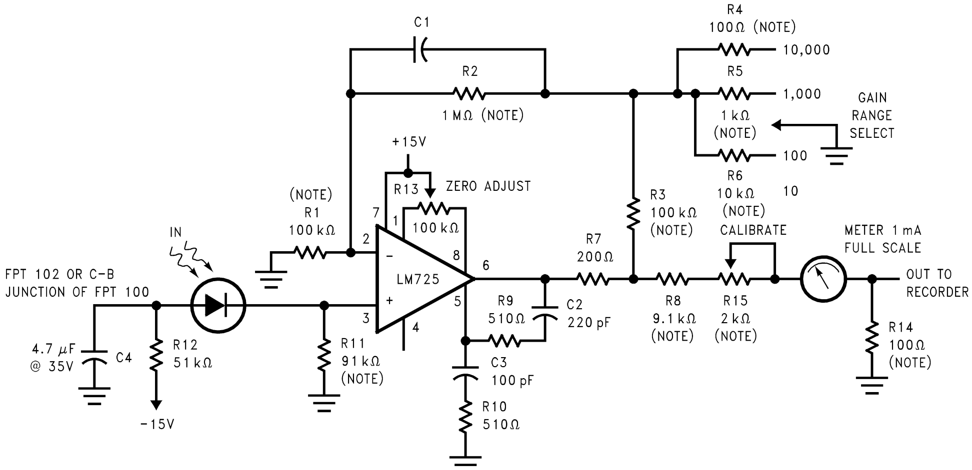


Compensation Component Values

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



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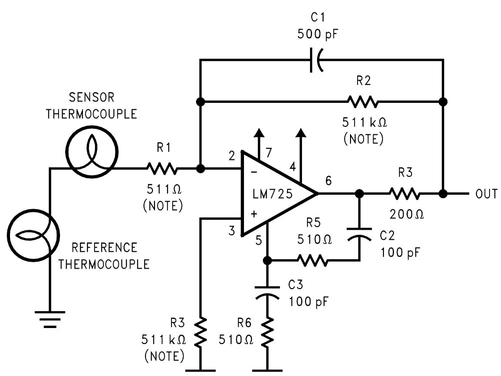
DC Gains = 10,000; 1,000; 100; and 10
Bandwidth = Determined by value of C1

Thermocouple Amplifier



DS010474-10

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

R1 = R4
R2 = R5

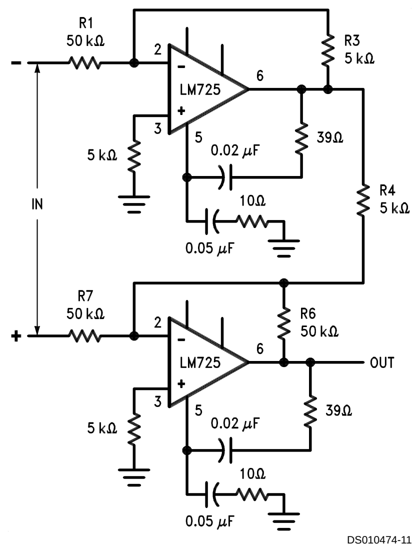
Gain $= \frac{R6}{R2} + \left(\frac{2R1}{R3}\right)$

DC Gain = 1000
Bandwidth = DC to 540 Hz
Equivalent Input Noise = 0.24 μV_{rms}

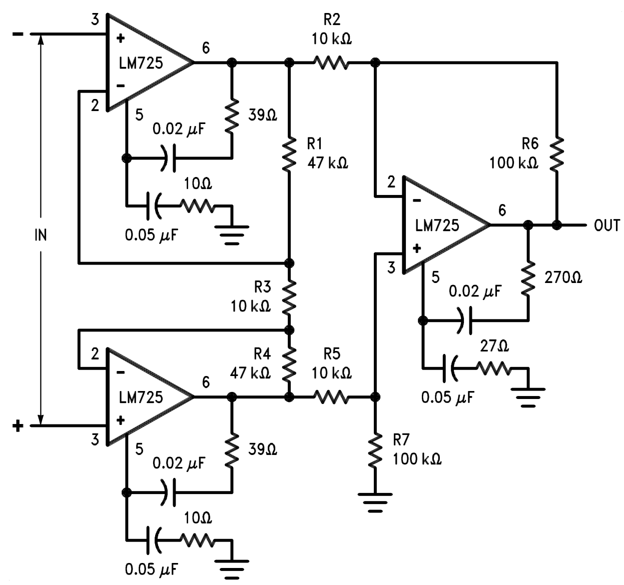
Note: Indicates ±1% metal film resistors recommended for temperature stability.

Typical Applications (Continued)

±100V Common Mode Range Differential Amplifier



Instrumentation Amplifier with High Common Mode Rejection



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

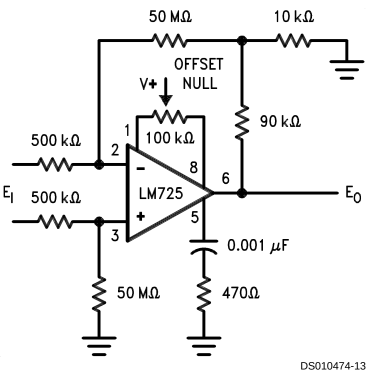
$R3 = R4$

$R1 = R6 = 10\ R3$

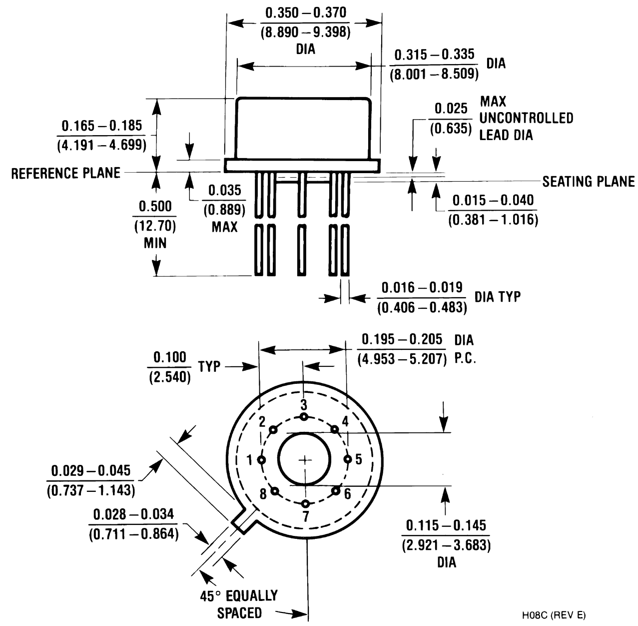
$\text{Gain} = \frac{R6}{R7}$

Typical Applications (Continued)

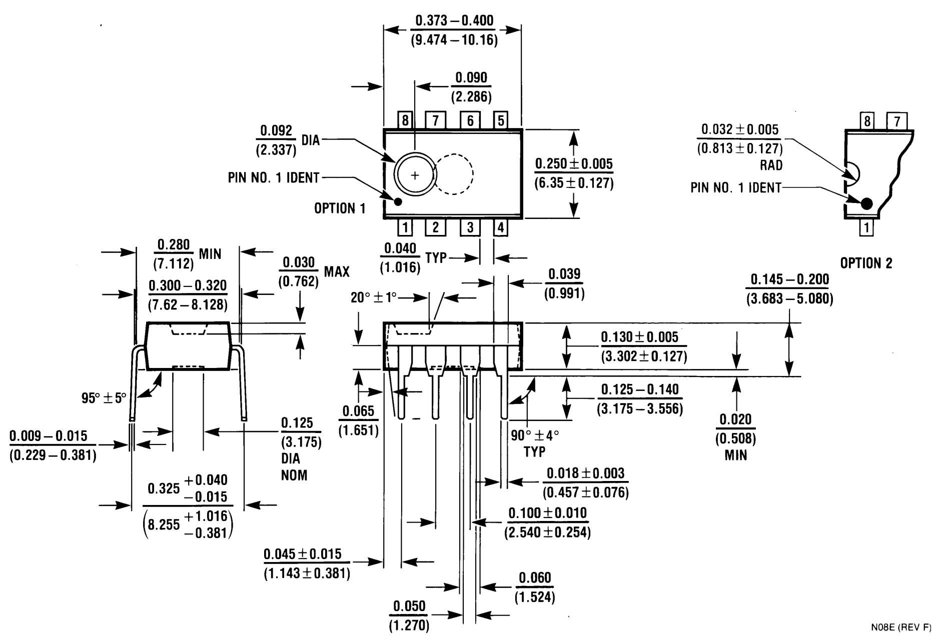
Precision Amplifier A_{VCL} = 1000



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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