National Semiconductor

December 1994

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.

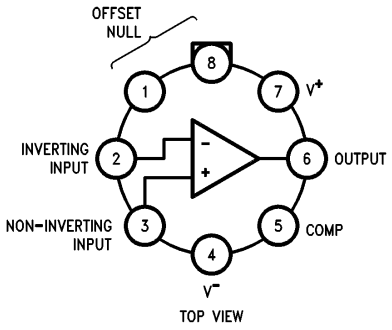
The LM725A has tightened electrical performance with higher input accuracy and like the LM725, is guaranteed over a −55°C to +125°C temperature range. The LM725C has slightly relaxed specifications and has its performance guaranteed over a 0°C to 70°C temperature range.

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 and Ordering Information

Metal Can Package



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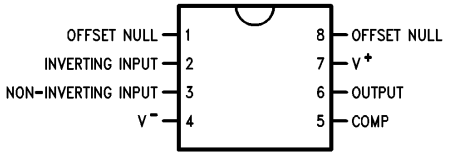
Order Number LM725H/883, LM725CH or LM725AH/883
See NS Package Number H08C

Dual-In-Line Package



TL/H/10474–2

Order Number LM725CN
See NS Package Number N08E

RRD-B30M115/Printed in U. S. A.

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)	$T_A = 25°C$, $R_S \leq 10\ k\Omega$			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 $f_o = 100$ Hz $f_o = 1$ kHz		 15 9.0 8.0			 15 9.0 8.0			 15 9.0 8.0		 $nV/\sqrt{Hz}$ $nV/\sqrt{Hz}$ $nV/\sqrt{Hz}$
Input Noise Current	$T_A = 25°C$ $f_o = 10$ Hz $f_o = 100$ Hz $f_o = 1$ kHz		 1.0 0.3 0.15			 1.0 0.3 0.15			 1.0 0.3 0.15		 $pA/\sqrt{Hz}$ $pA/\sqrt{Hz}$ $pA/\sqrt{Hz}$
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	$T_A = 25°C$, $R_L \geq 2\ k\Omega$, $V_{OUT} = \pm 10V$	1000	3000		1000	3000		250	3000		V/mV
Common-Mode Rejection Ratio	$T_A = 25°C$, $R_S \leq 10\ k\Omega$	120			110	120		94	120		dB
Power Supply Rejection Ratio	$T_A = 25°C$, $R_S \leq 10\ k\Omega$		2.0	5.0		2.0	10		2.0	35	μV/V
Output Voltage Swing	$T_A = 25°C$, $R_L \geq 10\ k\Omega$ $R_L \geq 2\ k\Omega$	 ±12.5 ±12.0	 ±13.5 ±13.5		 ±12 ±10	 ±13.5 ±13.5		 ±12 ±10	 ±13.5 ±13.5		 V V
Power Consumption	$T_A = 25°C$		80	105		80	105		80	150	mW
Input Offset Voltage (Without External Trim)	$R_S \leq 10\ k\Omega$			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		μV/°C
Average Input Offset Voltage Drift (With External Trim)	$R_S = 50\Omega$		0.6	1.0		0.6			0.6		μV/°C
Input Offset Current	$T_A = T_{MAX}$ $T_A = T_{MIN}$		1.2 7.5	4.0 18.0		1.2 7.5	20 40		1.2 4.0	35 50	nA nA
Average Input Offset Current Drift			35	90		35	150		10		pA/°C
Input Bias Current	$T_A = T_{MAX}$ $T_A = T_{MIN}$		20 80	70 180		20 80	100 200			125 250	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	$R_L \geq 2\ k\Omega$ $T_A = T_{MAX}$	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

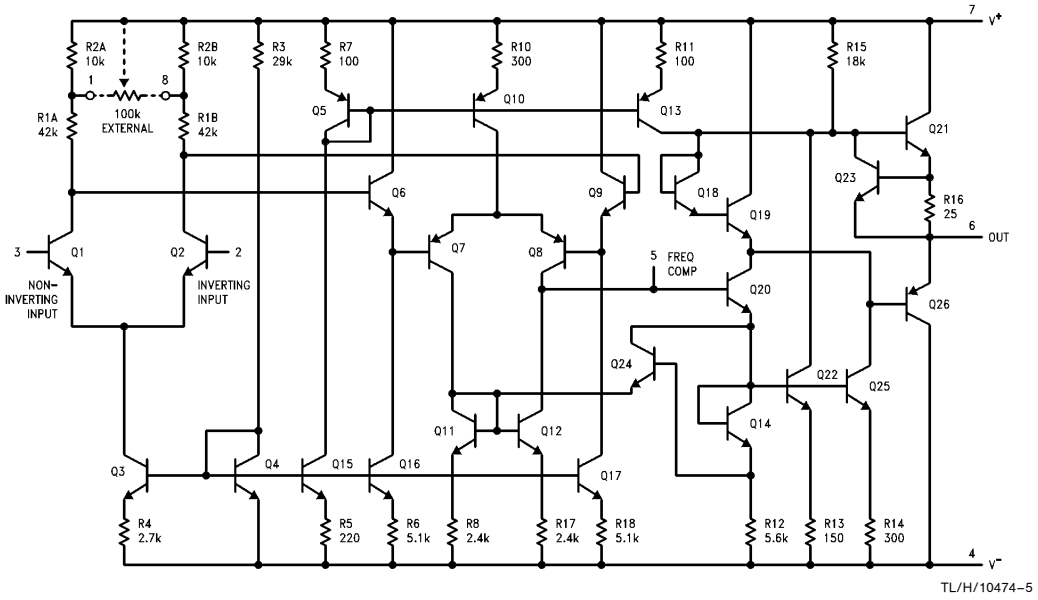
Note 1: Derate at 150°C/W for operation at ambient temperatures above 75°C.

Note 2: For supply voltages less than ± 22V, the absolute maximum input voltage is equal to the supply voltage.

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

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

Schematic Diagram



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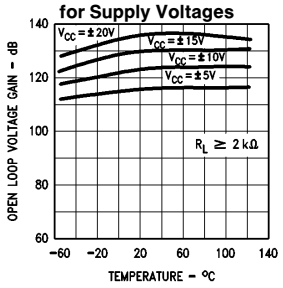
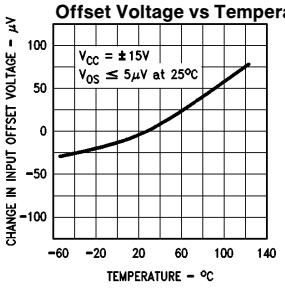
Typical Performance Characteristics

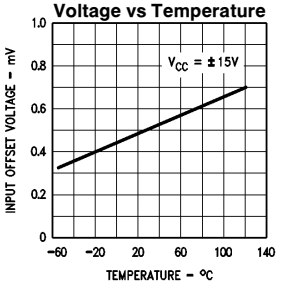
Voltage Gain vs Temperature for Supply Voltages



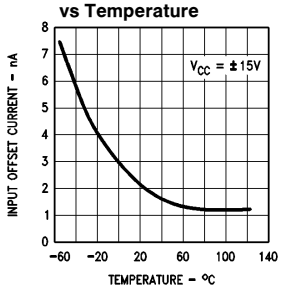
Change in Trimmed Input Offset Voltage vs Temperature



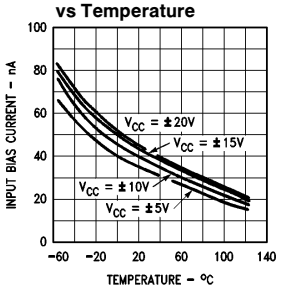
Untrimmed Input Offset Voltage vs Temperature



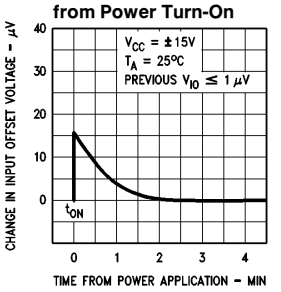
Input Offset Current vs Temperature



Input Bias Current vs Temperature



Stabilization Time of Input Offset Voltage from Power Turn-On



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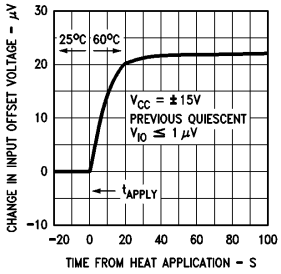
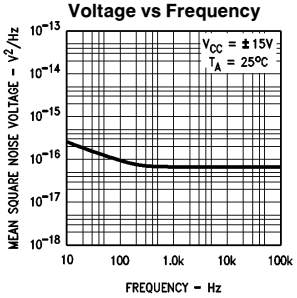
Typical Performance Characteristics (Continued)

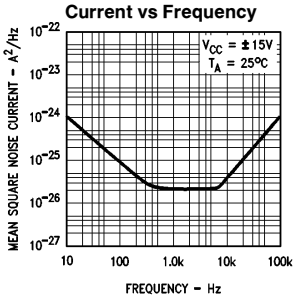
Change in Input Offset Voltage Due to Thermal Shock vs Time



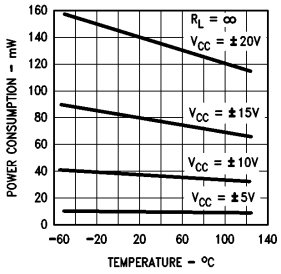
Input Noise Voltage vs Frequency



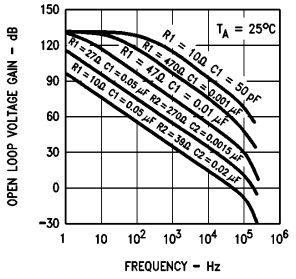
Input Noise Current vs Frequency



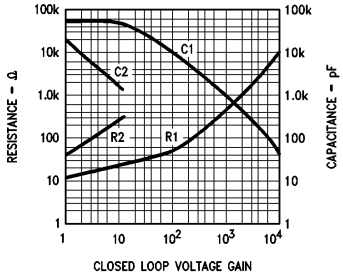
Power Consumption vs Temperature



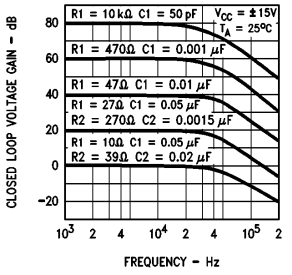
Open Loop Frequency Response for Values of Compensation (Note 1)



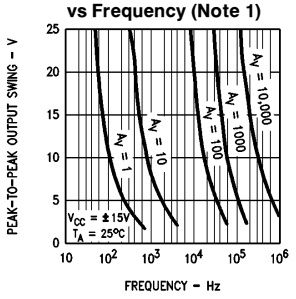
Values for Suggested Compensation Networks vs Various Close Loop Voltage Gains



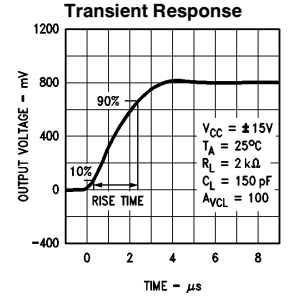
Frequency Response for Various Close Loop Gain (Note 1)



Output Voltage Swing vs Frequency (Note 1)



Transient Response



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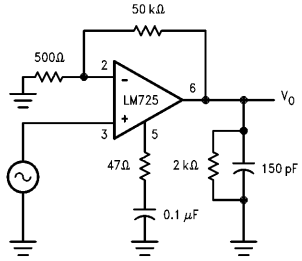
Note 1: Performance is shown using recommended compensation networks.

Transient Response Test Circuit



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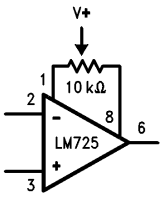
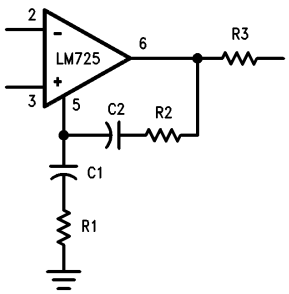
Auxiliary Circuits

Voltage Offset Null Circuit



TL/H/10474–3

Frequency Compensation Circuit



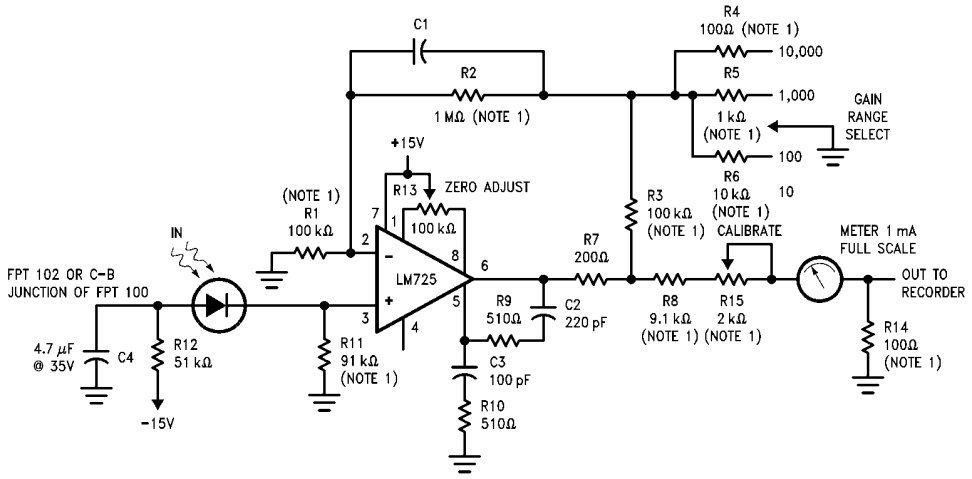
TL/H/10474–4

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



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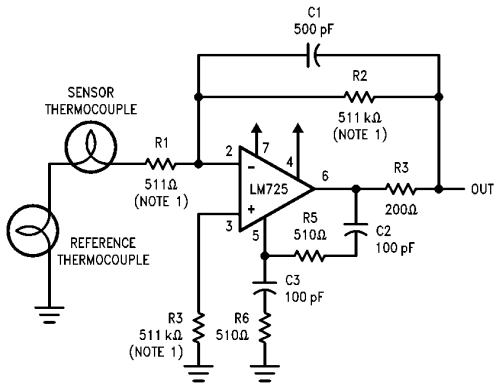
DC Gains = 10,000; 1,000; 100; and 10
Bandwidth = Determined by value of C1

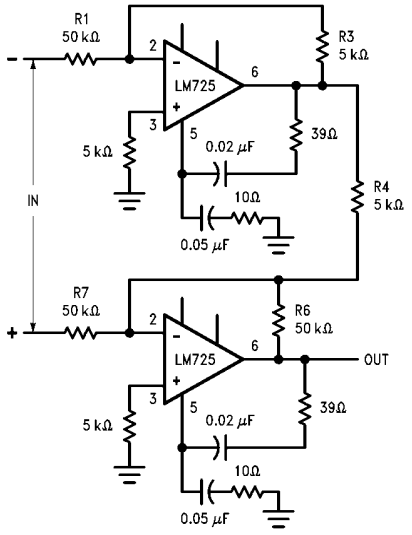
Thermocouple Amplifier



TL/H/10474–10

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

±100V Common Mode Range Differential Amplifier

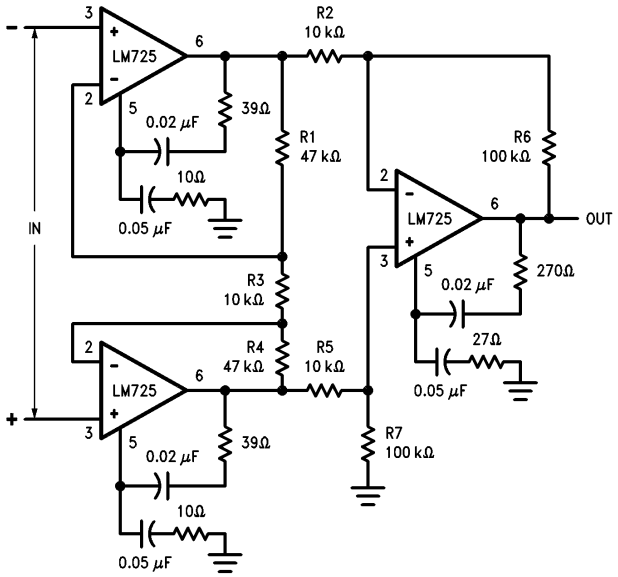


TL/H/10474–11

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

Typical Applications (Continued)

Instrumentation Amplifier with High Common Mode Rejection



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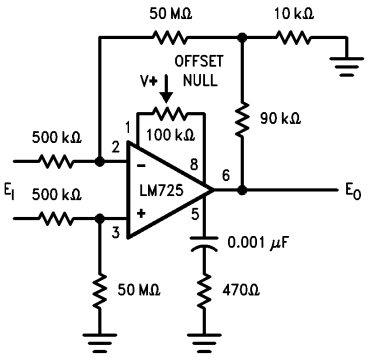
$\frac{R1}{R6} = \frac{R3}{R4}$ for best CMRR

R3 = R4

R1 = R6 = 10 R3

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

Precision Amplifier A_{VCL} = 1000



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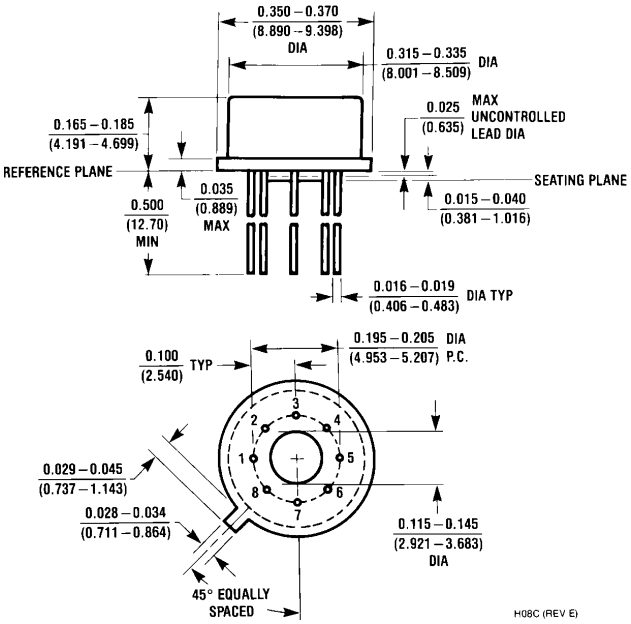
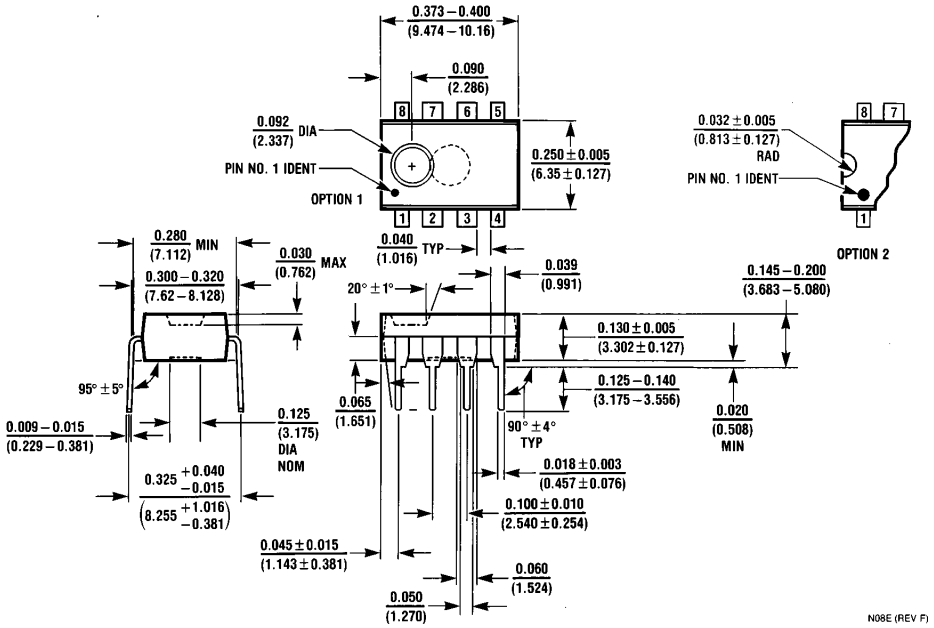
Physical Dimensions inches (millimeters)



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

Physical Dimensions inches (millimeters) (Continued)



Order Number LM725CN
NS Package Number N08E

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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