National Semiconductor

LMC6492 Dual/LMC6494 Quad CMOS Rail-to-Rail Input and Output Operational Amplifier

General Description

The LMC6492/LMC6494 amplifiers were specifically developed for single supply applications that operate from −40˚C to +125˚C. This feature is well-suited for automotive systems because of the wide temperature range. A unique design topology enables the LMC6492/LMC6494 common-mode voltage range to accommodate input signals beyond the rails. This eliminates non-linear output errors due to input signals exceeding a traditionally limited common-mode voltage range. The LMC6492/LMC6494 signal range has a high CMRR of 82 dB for excellent accuracy in non-inverting circuit configurations.

The LMC6492/LMC6494 rail-to-rail input is complemented by rail-to-rail output swing. This assures maximum dynamic signal range which is particularly important in 5V systems.

Ultra-low input current of 150 fA and 120 dB open loop gain provide high accuracy and direct interfacing with high impedance sources.

Features

(Typical unless otherwise noted)

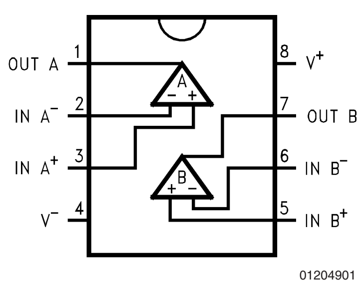
- Rail-to-Rail input common-mode voltage range, guaranteed over temperature
- Rail-to-Rail output swing within 20 mV of supply rail, 100 kΩ load
- Operates from 5V to 15V supply
- Excellent CMRR and PSRR 82 dB
- Ultra low input current 150 fA
- High voltage gain (R_L = 100 kΩ) 120 dB
- Low supply current (@ V_S = 5V) 500 µA/Amplifier
- Low offset voltage drift 1.0 µV/˚C

Applications

- Automotive transducer amplifier
- Pressure sensor
- Oxygen sensor
- Temperature sensor
- Speed sensor

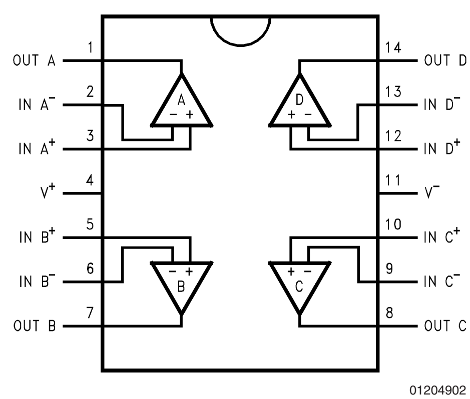
Connection Diagrams

8-Pin DIP/SO



Top View

14-Pin DIP/SO



Top View

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

ESD Tolerance (Note 2)	2000V
Differential Input Voltage	±Supply Voltage
Voltage at Input/Output Pin	$(V^+) + 0.3V$, $(V^-) - 0.3V$
Supply Voltage ($V^+ - V^-$)	16V
Current at Input Pin	±5 mA
Current at Output Pin (Note 3)	±30 mA
Current at Power Supply Pin	40 mA
Lead Temp. (Soldering, 10 sec.)	260˚C
Storage Temperature Range	−65˚C to +150˚C
Junction Temperature (Note 4)	150˚C

Operating Conditions (Note 1)

Supply Voltage	$2.5V \leq V^+ \leq 15.5V$
Junction Temperature Range	
LMC6492AE, LMC6492BE	$-40˚C \leq T_J \leq +125˚C$
LMC6494AE, LMC6494BE	$-40˚C \leq T_J \leq +125˚C$
Thermal Resistance (θ_{JA})	
N Package, 8-Pin Molded DIP	108˚C/W
M Package, 8-Pin Surface Mount	171˚C/W
N Package, 14-Pin Molded DIP	78˚C/W
M Package, 14-Pin Surface Mount	118˚C/W

DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25˚C$, $V^+ = 5V$, $V^- = 0V$, $V_{CM} = V_O = V^+/2$ and $R_L > 1 M\Omega$. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6492AE LMC6494AE Limit (Note 6)	LMC6492BE LMC6494BE Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		0.11	3.0 **3.8**	6.0 **6.8**	mV max
TCV_{OS}	Input Offset Voltage Average Drift		1.0			μV/˚C
I_B	Input Bias Current	(Note 11)	0.15	**200**	**200**	pA max
I_{OS}	Input Offset Current	(Note 11)	0.075	**100**	**100**	pA max
R_{IN}	Input Resistance		>10			Tera Ω
C_{IN}	Common-Mode Input Capacitance		3			pF
CMRR	Common-Mode Rejection Ratio	$0V \leq V_{CM} \leq 15V$ $V^+ = 15V$	82	65 **60**	63 **58**	dB min
		$0V \leq V_{CM} \leq 5V$	82	65 **60**	63 **58**	
+PSRR	Positive Power Supply Rejection Ratio	$5V \leq V^+ \leq 15V$, $V_O = 2.5V$	82	65 **60**	63 **58**	dB min
−PSRR	Negative Power Supply Rejection Ratio	$0V \leq V^- \leq -10V$, $V_O = 2.5V$	82	65 **60**	63 **58**	dB min
V_{CM}	Input Common-Mode Voltage Range	$V^+ = 5V$ and 15V For CMRR ≥ 50 dB	V^- −0.3	−0.25 **0**	−0.25 **0**	V max
			V^+ + 0.3	V^+ + 0.25 **V^+**	V^+ + 0.25 **V^+**	V min
A_V	Large Signal Voltage Gain	$R_L = 2 k\Omega$: Sourcing (Note 7)	300			V/mV
		Sinking	40			min

DC Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ C$, $V^+ = 5V$, $V^- = 0V$, $V_{CM} = V_O = V^+/2$ and $R_L > 1\ M\Omega$. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6492AE LMC6494AE Limit (Note 6)	LMC6492BE LMC6494BE Limit (Note 6)	Units
V_O	Output Swing	$V^+ = 5V$ $R_L = 2\ k\Omega$ to $V^+/2$	4.9	4.8 **4.7**	4.8 **4.7**	V min
			0.1	0.18 **0.24**	0.18 **0.24**	V max
		$V^+ = 5V$ $R_L = 600\Omega$ to $V^+/2$	4.7	4.5 **4.24**	4.5 **4.24**	V min
			0.3	0.5 **0.65**	0.5 **0.65**	V max
		$V^+ = 15V$ $R_L = 2\ k\Omega$ to $V^+/2$	14.7	14.4 **14.0**	14.4 **14.0**	V min
			0.16	0.35 **0.5**	0.35 **0.5**	V max
		$V^+ = 15V$ $R_L = 600\Omega$ to $V^+/2$	14.1	13.4 **13.0**	13.4 **13.0**	V min
			0.5	1.0 **1.5**	1.0 **1.5**	V max
I_{SC}	Output Short Circuit Current $V^+ = 5V$	Sourcing, $V_O = 0V$	25	16 **10**	16 **10**	mA min
		Sinking, $V_O = 5V$	22	11 **8**	11 **8**	mA min
I_{SC}	Output Short Circuit Current $V^+ = 15V$	Sourcing, $V_O = 0V$	30	28 **20**	28 **20**	mA min
		Sinking, $V_O = 5V$ (Note 8)	30	30 **22**	30 **22**	mA min
I_S	Supply Current	LMC6492 $V^+ = +5V$, $V_O = V^+/2$	1.0	1.75 **2.1**	1.75 **2.1**	mA max
		LMC6492 $V^+ = +15V$, $V_O = V^+/2$	1.3	1.95 **2.3**	1.95 **2.3**	mA max
		LMC6494 $V^+ = +5V$, $V_O = V^+/2$	2.0	3.5 **4.2**	3.5 **4.2**	mA max
		LMC6494 $V^+ = +15V$, $V_O = V^+/2$	2.6	3.9 **4.6**	3.9 **4.6**	mA max

AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, V_{CM} = V_O = $V^+/2$ and R_L > 1 MΩ. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6492AE LMC6494AE Limit (Note 6)	LMC6492BE LMC6494BE Limit (Note 6)	Units
SR	Slew Rate	(Note 9)	1.3	0.7 **0.5**	0.7 **0.5**	Vμs min
GBW	Gain-Bandwidth Product	V^+ = 15V	1.5			MHz
ϕ_m	Phase Margin		50			Deg
G_m	Gain Margin		15			dB
	Amp-to-Amp Isolation	(Note 10)	150			dB
e_n	Input-Referred Voltage Noise	F = 1 kHz V_{CM} = 1V	37			$\frac{nV}{\sqrt{HZ}}$
i_n	Input-Referred Current Noise	F = 1 kHz	0.06			$\frac{pA}{\sqrt{HZ}}$
T.H.D.	Total Harmonic Distortion	F = 1 kHz, A_V = −2 R_L = 10 kΩ, V_O = −4.1 V_{PP}	0.01			%
		F = 10 kHz, A_V = −2 R_L = 10 kΩ, V_O = 8.5 V_{PP} V^+ = 10V	0.01			

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: Human body model, 1.5 kΩ in series with 100 pF.

Note 3: Applies to both single-supply and split-supply operation. Continuous short operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature at 150˚C. Output currents in excess of ±30 mA over long term may adversely affect reliability.

Note 4: The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA} and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

Note 5: Typical Values represent the most likely parametric norm.

Note 6: All limits are guaranteed by testing or statistical analysis.

Note 7: V^+ = 15V, V_{CM} = 7.5V and R_L connected to 7.5V. For Sourcing tests, 7.5V ≤ V_O ≤ 11.5V. For Sinking tests, 3.5V ≤ V_O ≤ 7.5V.

Note 8: Do not short circuit output to V^+, when V^+ is greater than 13V or reliability will be adversely affected.

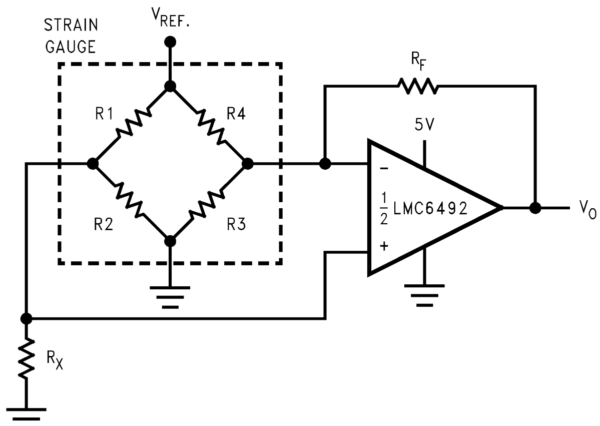
Note 9: V^+ = 15V. Connected as voltage follower with 10V step input. Number specified is the slower of the positive and negative slew rates.

Note 10: Input referred, V^+ = 15V and R_L = 100 kΩ connected to 7.5V. Each amp excited in turn with 1 kHz to produce V_O = 12 V_{PP}.

Note 11: Guaranteed limits are dictated by tester limits and not device performance. Actual performance is reflected in the typical value.

Application Circuits (Continued)

Pressure Sensor



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$R_f = R_x$

$R_f >> R1, R2, R3,$ and $R4$

$$V_O = \left(\frac{R2}{R1 + R2} - \frac{R3}{R4 + R3}\right) \frac{R_f\,(R3 + R4)}{R3\,R4} V_{REF}$$

In a manifold absolute pressure sensor application, a strain gauge is mounted on the intake manifold in the engine unit. Manifold pressure causes the sensing resistors, R1, R2, R3 and R4 to change. The resistors change in a way such that R2 and R4 increase by the same amount R1 and R3 decrease. This causes a differential voltage between the input of the amplifier. The gain of the amplifier is adjusted by R_f.

Spice Macromodel

A spice macromodel is available for the LMC6492/4. This model includes accurate simulation of:

- Input common-model voltage range
- Frequency and transient response
- GBW dependence on loading conditions
- Quiescent and dynamic supply current
- Output swing dependence on loading conditions

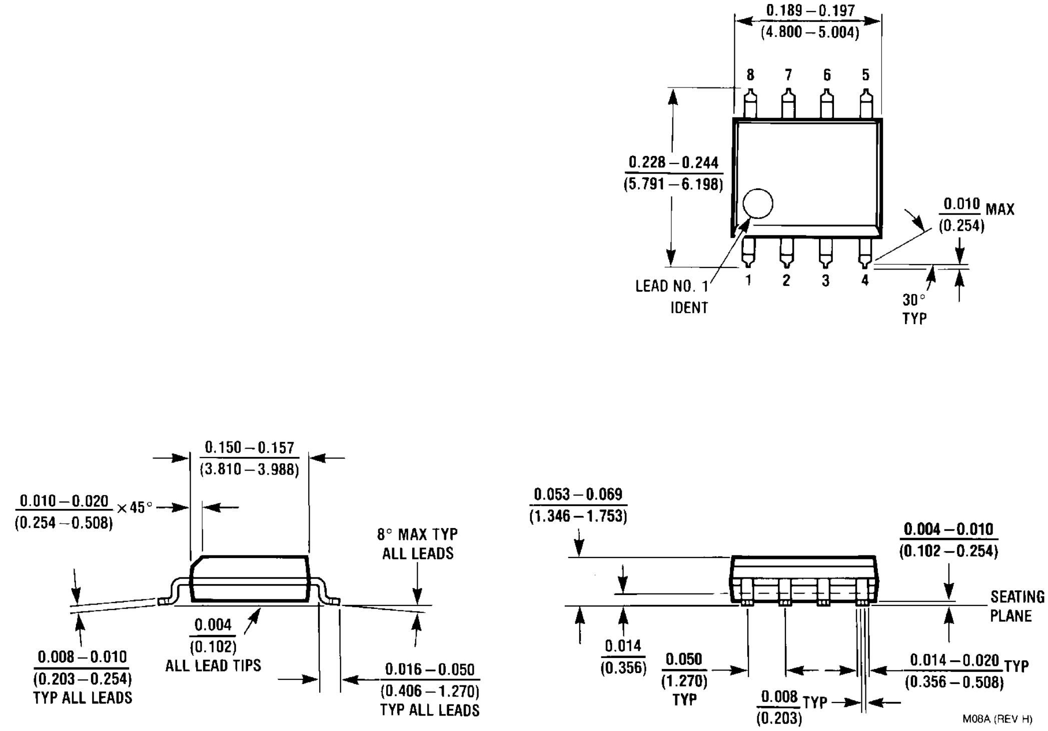
and many other characteristics as listed on the macromodel disk.

Contact your local National Semiconductor sales office to obtain an operational amplifier spice model library disk.

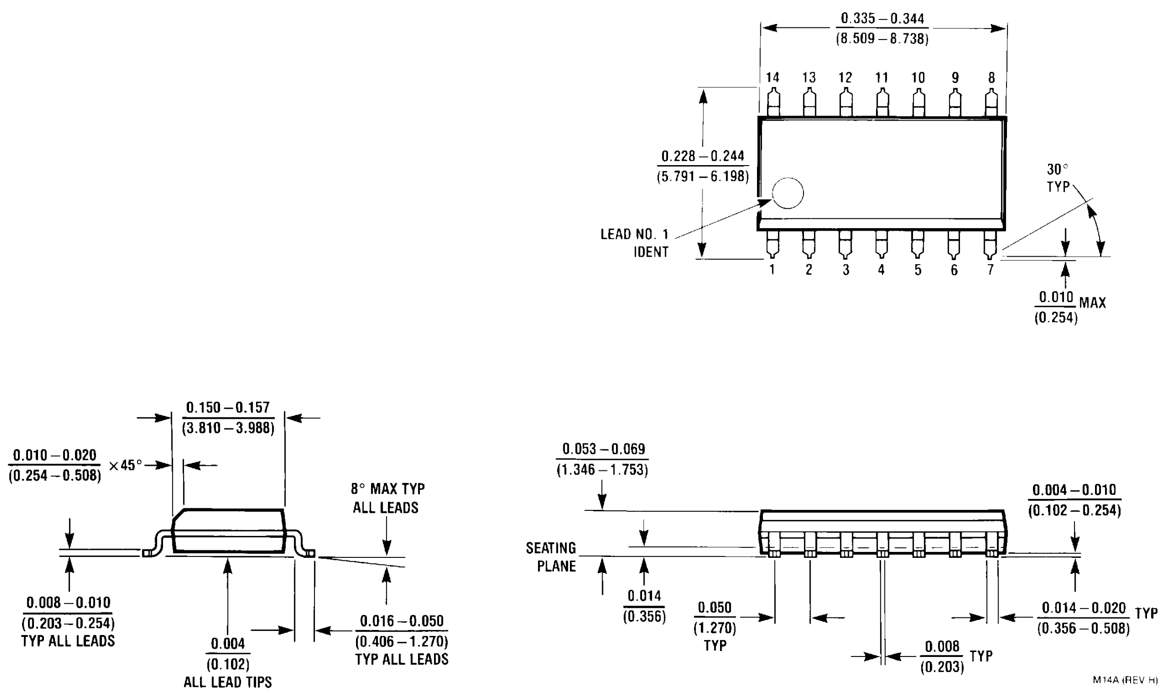
Ordering Information

Package	Temperature Range Extended −40˚C to +125˚C	Transport Media	NSC Drawing
8-Pin Small Outline	LMC6492AEM	Rails	M08A
	LMC6492BEM		
	LMC6492AEMX	Tape and Reel	
	LMC6492BEMX		
8-Pin Molded DIP	LMC6492AEN	Rails	N08A
	LMC6492BEN		
14-Pin Small Outline	LMC6494AEM	Rails	M14A
	LMC6494BEM		
	LMC6494AEMX	Tape and Reel	
	LMC6494BEMX		
14-Pin Molded DIP	LMC6494AEN	Rails	N14A
	LMC6494BEN		

Physical Dimensions inches (millimeters) unless otherwise noted



8-Pin Small Outline Package
Order Number LMC6492AEM or LMC6492BEM
NS Package Number M08A



14-Pin Small Outline Package
Order Number LMC6494AEM or LMC6494BEM
NS Package Number M14A