Operational Amplifiers

LM2902 quad op amp

general description

The LM2902 consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically for automotive and industrial control systems. They operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

unique characteristics

- In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.
- The unity gain cross frequency is temperature compensated.
- The input bias current is also temperature compensated.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM2902 can be directly operated off of the standard $+5V_{DC}$ power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional $\pm15V_{DC}$ power supplies.

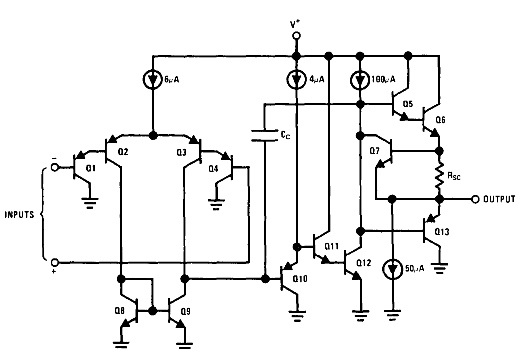
advantages

- Eliminates need for dual supplies
- Four internally compensated op amps in a single package
- Allows directly sensing near GND and V_{OUT} also goes to GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

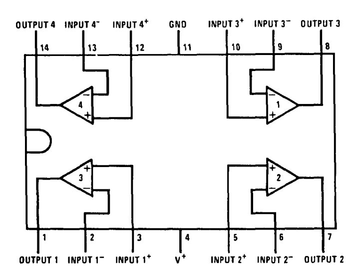
features

- Internally frequency compensated for unity gain
- Large DC voltage gain 100 dB
- Wide bandwidth (unity gain) (temperature compensated) 1 MHz
- Wide power supply range
  - Single supply $3\ V_{DC}$ to $26\ V_{DC}$
  - or dual supplies $\pm1.5\ V_{DC}$ to $\pm13\ V_{DC}$
- Very low supply current drain (800μA) — essentially independent of supply voltage (1 mW/op amp at $+5V_{DC}$)
- Low input biasing current (temperature compensated) $45\ nA_{DC}$
- Low input offset voltage $2\ mV_{DC}$ and offset current $5\ nA_{DC}$
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing $0V_{DC}$ to $V^+ - 1.5V_{DC}$

schematic and connection diagrams



Dual-In-Line Package



Order Number LM2902N
See Package 22

absolute maximum ratings

Supply Voltage, V^+	32 V_{DC} or ±13 V_{DC}
Differential Input Voltage	26 V_{DC}
Input Voltage	−0.3 V_{DC} to +26 V_{DC}
Power Dissipation (Note 1)	570 mW
Output Short-Circuit to GND (Note 2) $V^+ \leq 15\ V_{DC}$ and T_A = 25°C	Continuous
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C

electrical characteristics ($V^+ = +5V_{DC}$ and T_A = 25°C unless otherwise noted)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S = 0\Omega$		2	10	mV_{DC}
Input Bias Current (Note 3)	$I_{IN(+)}$ or $I_{IN(-)}$		45	500	nA_{DC}
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$		±5	±50	nA_{DC}
Input Common-Mode Voltage Range (Note 4)		0		V^+−1.5	V_{DC}
Supply Current	$R_L = \infty$ On All Op Amps		0.8	2	mA_{DC}
Large Signal Voltage Gain	$R_L \geq 2\ k\Omega$		100		V/mV
Output Voltage Swing	$R_L = 2\ k\Omega$	0		V^+−1.5	V_{DC}
Common Mode Rejection Ratio	DC		85		dB
Power Supply Rejection Ratio	DC		100		dB
Amplifier-to-Amplifier Coupling	f = 1 kHz to 20 kHz (Input Referred)		−120		dB
Output Current Source	$V_{IN}^+ = +1\ V_{DC}$, $V_{IN}^- = 0\ V_{DC}$	20	40		mA_{DC}
Output Current Sink	$V_{IN}^- = +1\ V_{DC}$, $V_{IN}^+ = 0\ V_{DC}$	8	20		mA_{DC}

Note 1: For operating at high temperatures, the LM2902 must be derated based on a +125°C maximum junction temperature and a thermal resistance of 175°C/W which applies for the device soldered in a printed circuit board operating in a still air ambient.

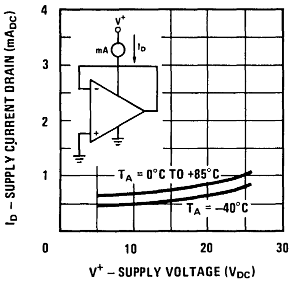
Note 2: Short circuits from the output to V^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 40 mA independent of the magnitude of V^+. At values of supply voltage in excess of $+15V_{DC}$, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.

Note 3: The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

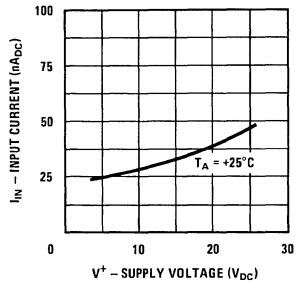
Note 4: The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V^+ - 1.5V$, but either or both inputs can go to $+26V_{DC}$ without damage.

typical performance characteristics

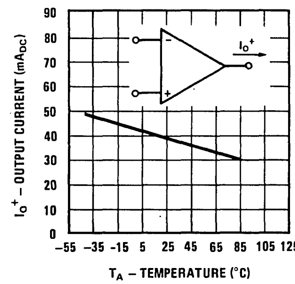
Supply Current



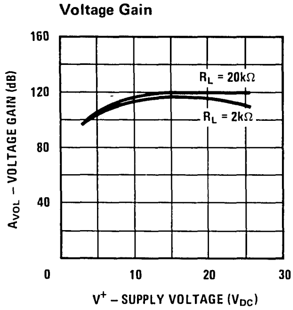
Input Current



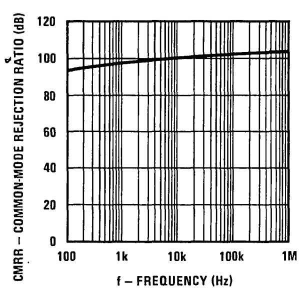
Current Limiting



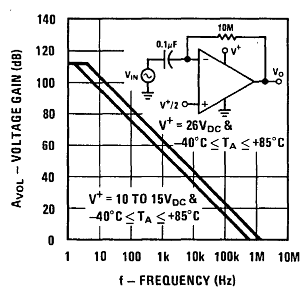
Voltage Gain



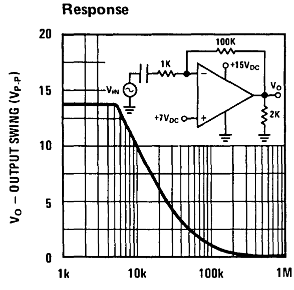
Common-Mode Rejection Ratio



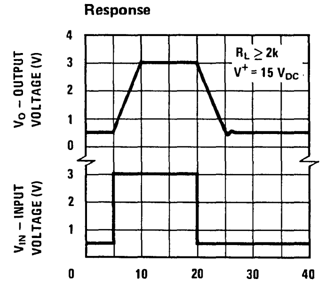
Open Loop Frequency Response



Large Signal Frequency Response



Voltage Follower Pulse Response



application hints

The LM2902 op amps operate with only a single power supply voltage, have true-differential inputs, and remain in the linear mode with an input common-mode voltage of $0V_{DC}$. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of $2.3V_{DC}$.

The pinouts of the package have been designed to simplify PC board layouts. Inverting inputs are adjacent to outputs for all of the amplifiers and the outputs have also been placed at the corners of the package (pins 1, 7, 8, and 14).

Precautions should be taken to insure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a test socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than $-0.3V_{DC}$ (at 25°C). An input clamp consisting of a diode-connected NPN transistor (C-B short) can be used.

To reduce the power supply current drain, the amplifiers have a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For AC applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and prevent crossover distortion. Where the load is directly coupled, as in DC applications, there is no crossover distortion.

Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50 pF can be accommodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if larger load capacitance must be driven by the amplifier.

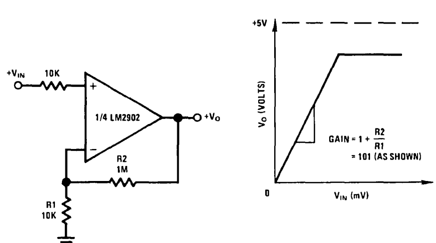
The bias network of the LM2902 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from $3V_{DC}$ to $26V_{DC}$.

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive junction temperatures. Putting direct short-circuits on more than one amplifier at a time will increase the total IC power dissipation to destructive levels, if not properly protected with external dissipation limiting resistors in series with the output leads of the amplifiers. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures (see typical performance characteristics) than a standard IC op amp.

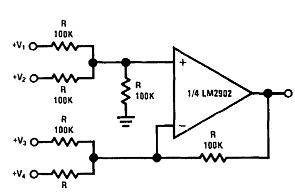
The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V^+/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

typical single-supply applications ($V^+ = 5\ V_{DC}$)

Non-Inverting DC Gain (0V Input = 0V Output)



DC Summing Amplifier
(V_{IN}'S $\geq 0V_{DC}$ AND $V_O \geq 0V_{DC}$)



WHERE $V_O = V_1 + V_2 - V_3 - V_4$
$(V_1 + V_2) \geq (V_3 + V_4)$ TO KEEP $V_O > 0V_{DC}$

typical single-supply applications (con't) ($V^+ = 5\ V_{DC}$)

High Input Z, DC Differential Amplifier

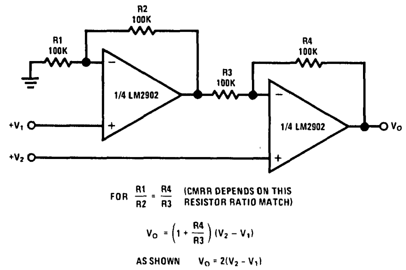
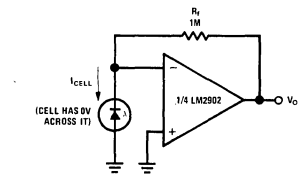
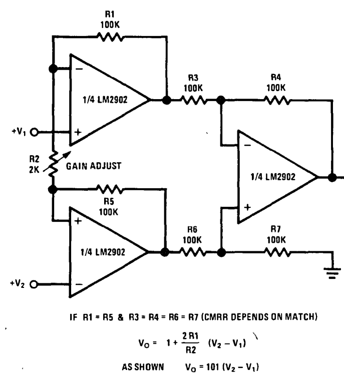


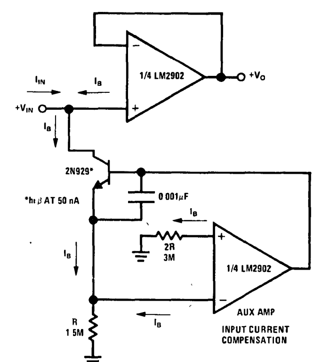
Photo Voltaic-Cell Amplifier



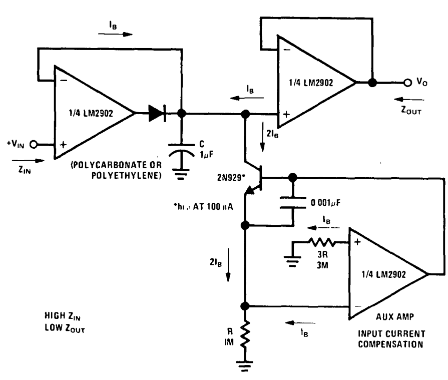
High Input Z Adjustable-Gain DC Instrumentation Amplifier



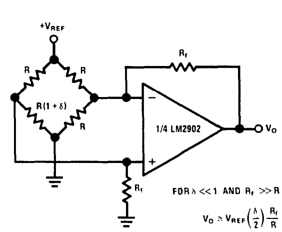
Using Symmetrical Amplifiers to Reduce Input Current (General Concept)



Low Drift Peak Detector

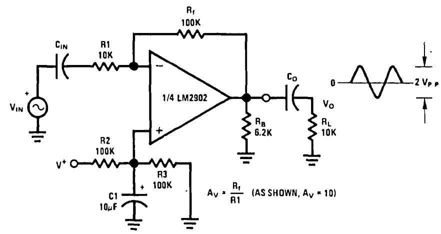


Bridge Current Amplifier

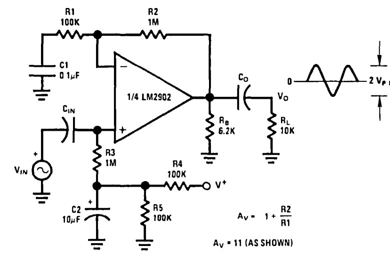


typical single-supply applications (con't) ($V^+ = 5\ V_{DC}$)

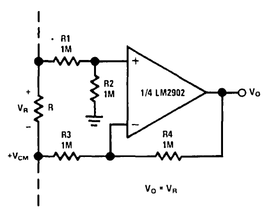
AC Coupled Inverting Amplifier



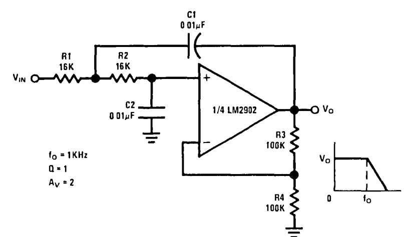
AC Coupled Non-Inverting Amplifier



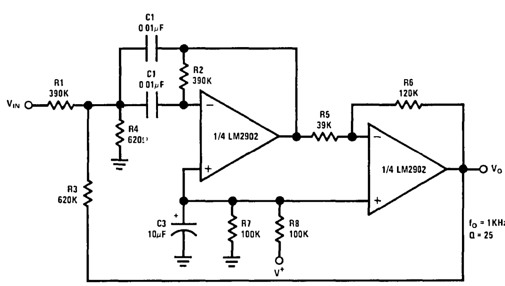
Ground Referencing A Differential Input Signal



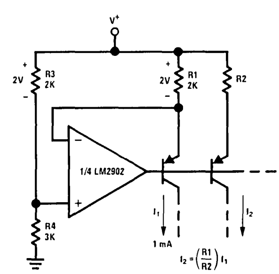
DC Coupled Low-Pass RC Active Filter



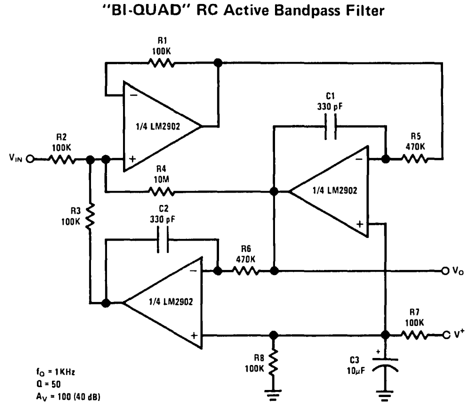
Bandpass Active Filter



Fixed Current Sources

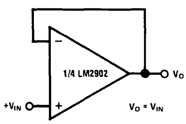


"BI-QUAD" RC Active Bandpass Filter

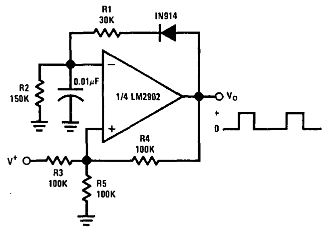


typical single-supply applications (con't) ($V^+ = 5\ V_{DC}$)

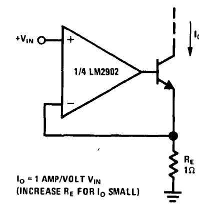
Voltage Follower



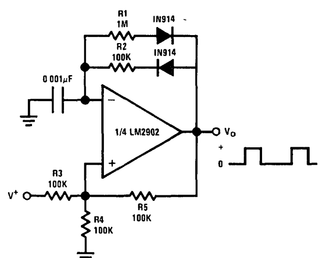
Pulse Generator



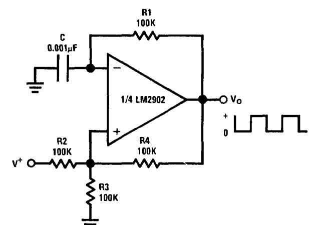
High Compliance Current Sink



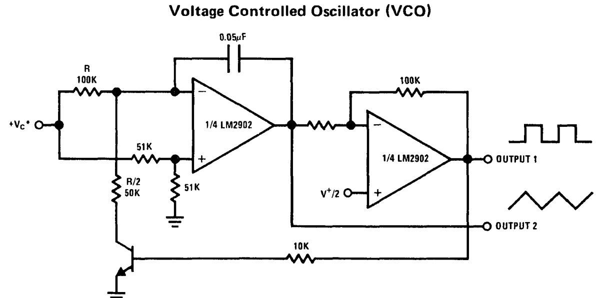
Pulse Generator



Squarewave Oscillator

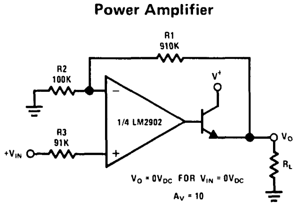


Voltage Controlled Oscillator (VCO)

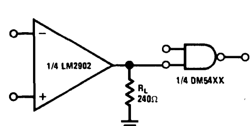


*WIDE CONTROL VOLTAGE RANGE: $0\ V_{DC} \leq V_C \leq 2(V^+ - 1.5\ V_{DC})$

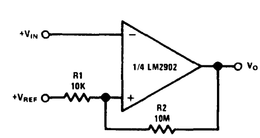
Power Amplifier



Driving TTL

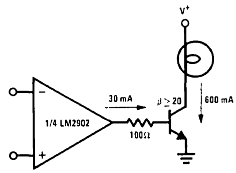


Comparator With Hysteresis

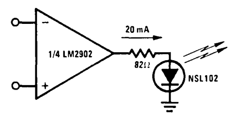


typical single-supply applications (con't) ($V^+ = 5\ V_{DC}$)

Lamp Driver



LED Driver



Current Monitor