



LM3900 quad amplifier

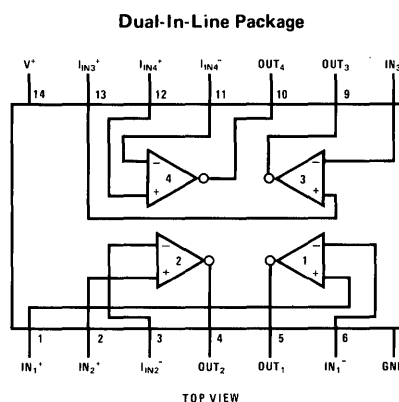
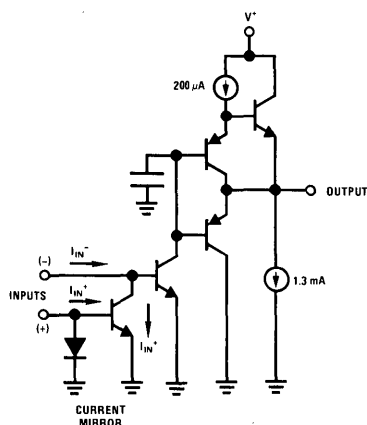
general description

The LM3900 consists of four independent, dual input, internally compensated amplifiers which were designed specifically to operate off of a single power supply voltage and to provide a large output voltage swing. These amplifiers make use of a current mirror to achieve the non-inverting input function. Application areas include: AC amplifiers, RC active filters; low frequency triangle, squarewave and pulse waveform generation circuits, tachometers and low speed, high voltage digital logic gates.

features

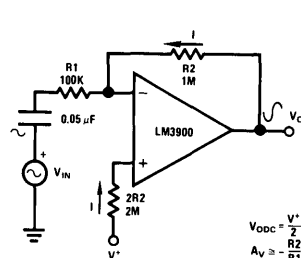
- Wide single supply voltage range $4 V_{DC}$ to $36 V_{DC}$
or dual supplies $\pm 2 V_{DC}$ to $\pm 18 V_{DC}$
- Supply current drain independent of supply voltage
- Low input biasing current 30 nA
- High open-loop gain 70 dB
- Wide bandwidth 2.5 MHz (Unity Gain)
- Large output voltage swing $(V^+ - 1) V_{p-p}$
- Internally frequency compensated for unity gain
- Output short-circuit protection

schematic and connection diagrams

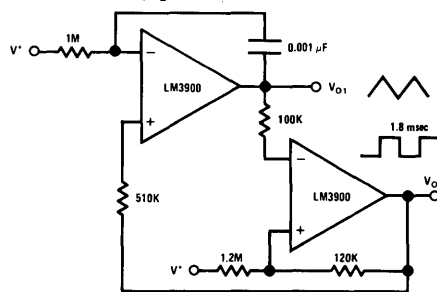


Order Number LM3900N
See Package 22

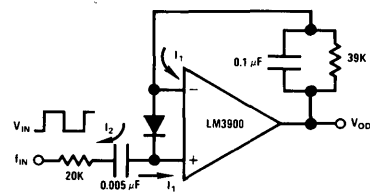
typical applications ($V^+ = 15V_{DC}$)



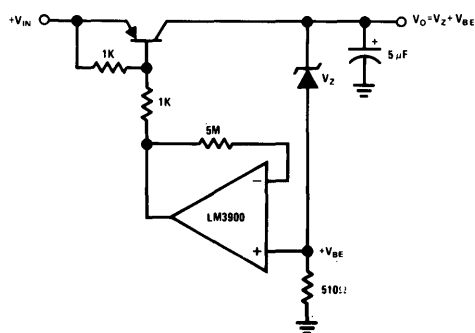
Inverting Amplifier



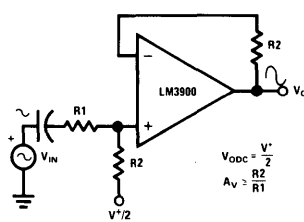
Triangle/Square Generator



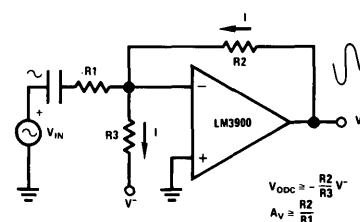
Frequency-Doubling Tachometer



Low V_{IN} - V_{OUT} Voltage Regulator



Non-Inverting Amplifier



Negative Supply Biasing

absolute maximum ratings

Supply Voltage	+36 VDC
	±18 VDC
Power Dissipation ($T_A = 25^\circ\text{C}$) (Note 1)	570 mW
Input Currents, I_{IN+} or I_{IN-}	20 mA DC
Output Short Circuit Duration — One Amplifier $T_A = 25^\circ\text{C}$ (See Application Hints)	Continuous
Operating Temperature Range	0°C to $+70^\circ\text{C}$
Storage Temperature Range	-65°C to $+150^\circ\text{C}$
Lead Temperature (Soldering, 60 sec)	300°C

electrical characteristics ($V^+ = +15\text{ VDC}$ and $T_A = 25^\circ\text{C}$ unless otherwise noted)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Open Loop					
Voltage Gain	$f = 100\text{ Hz}$	800	2800		V/V
Input Resistance	Inverting Input		1		$M\Omega$
Output Resistance			8		$k\Omega$
Unity Gain Bandwidth	Inverting Input		2.5		MHz
Input Bias Current	Inverting Input		30	200	nA
Slew Rate	Positive Output Swing		0.5		V/ μs
	Negative Output Swing		20		V/ μs
Supply Current	$R_L = \infty$ On All Amplifiers		6.2	10	mA DC
Output Voltage Swing	$R_L = 5.1k$				
V_{OUT} High	$I_{IN-} = 0, I_{IN+} = 0$	13.5	14.2		VDC
V_{OUT} Low	$I_{IN-} = 10\text{ }\mu\text{A}, I_{IN+} = 0$		0.09	0.2	VDC
Output Current Capability					
Source		3	10		mA DC
Sink	(Note 2)	0.5	1.3		mA DC
Power Supply Rejection	$f = 100\text{ Hz}$		70		dB
Mirror Gain	$I_{IN+} = 200\text{ }\mu\text{A}$ (Note 3)	0.80	1	1.16	$\mu\text{A}/\mu\text{A}$
Mirror Current	(Note 4)		10	500	μA DC
Negative Input Current	(Note 5)		1.0		mA DC

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

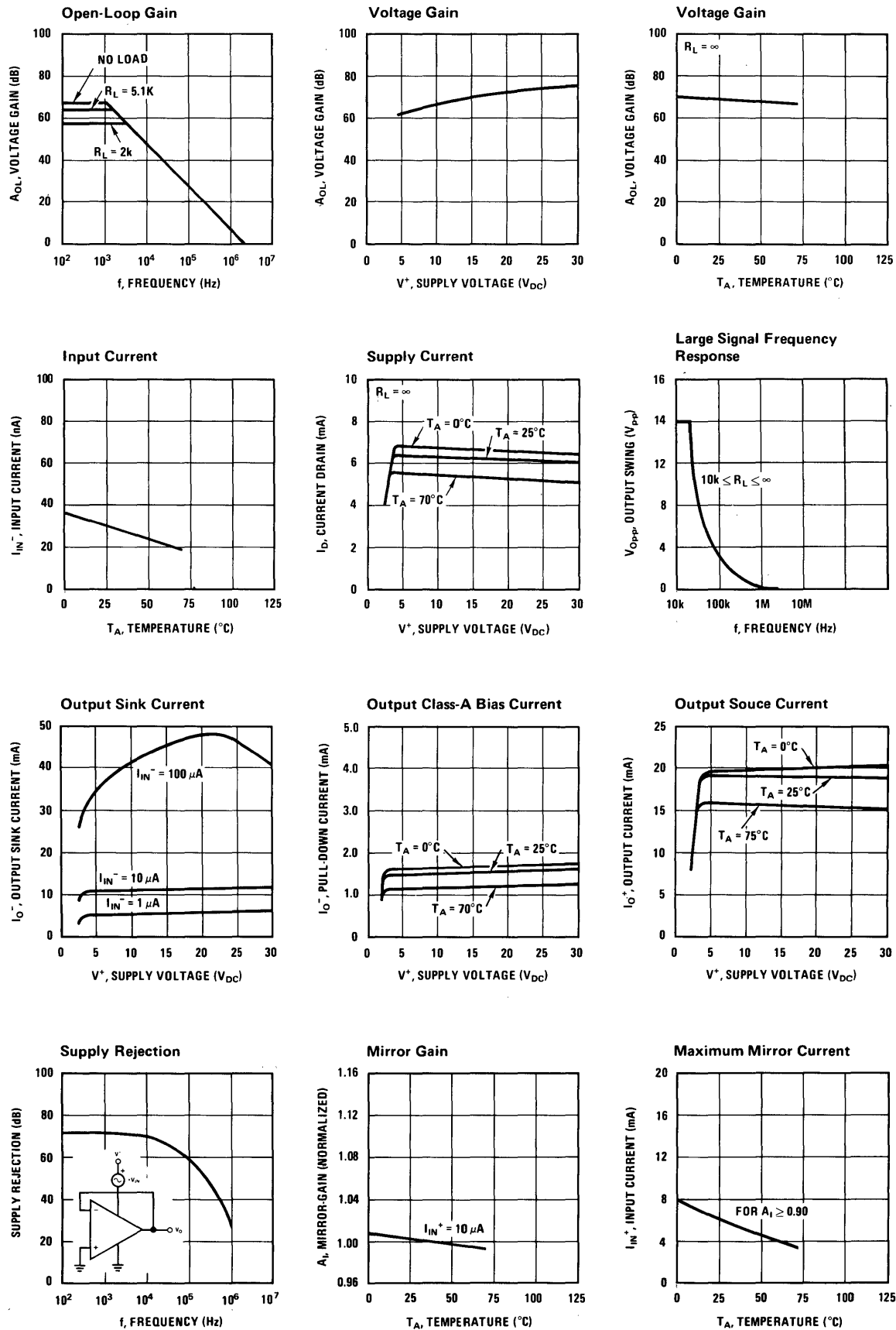
Note 2: The output current sink capability can be increased for large signal conditions by overdriving the inverting input. This is shown in the section on Typical Characteristics.

Note 3: This spec indicates the current gain of the current mirror which is used as the non-inverting input.

Note 4: Input V_{BE} match between the non-inverting and the inverting inputs occurs for a mirror current (non-inverting input current) of approximately $10\text{ }\mu\text{A}$. This is therefore a typical design center for many of the application circuits.

Note 5: Clamp transistors are included on the IC to prevent the input voltages from swinging below ground more than approximately -0.3 VDC . The negative input currents which may result from large signal overdrive with capacitance input coupling need to be externally limited to values of approximately 1 mA . Negative input currents in excess of 4 mA will cause the output voltage to drop to a low voltage. This maximum current applies to any one of the input terminals. If more than one of the input terminals are simultaneously driven negative smaller maximum currents are allowed. Common-mode current biasing can be used to prevent negative input voltages; see for example the "Differentiator Circuit" in the applications section.

typical performance characteristics



application hints

When driving either input from a low-impedance source, a limiting resistor should be placed in series with the input lead to limit the peak input current. Currents as large as 20 mA will not damage the device, but the current mirror on the non-inverting input will saturate and cause a loss of mirror gain at mA current levels — especially at high operating temperatures.

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.

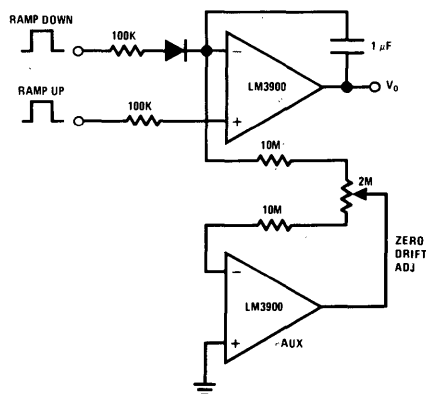
Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive junction temperatures. For example, when operating from a well-regulated +15 VDC power supply at $T_A = 25^\circ\text{C}$ with a 100 k Ω shunt-feedback resistor (from the output to the inverting input) a short directly to the power supply will not cause catastrophic failure but the current magnitude will be approximately 50 mA and the junction temperature will be above T_J max. Larger feedback resistors will reduce the current, 11 M Ω provides approximately 30 mA, an open circuit provides 1.3 mA, and a direct connection from the output to the non-inverting input will result in catastrophic failure when the output is shorted to V^+ as this then places the base-emitter junction of the input transistor directly across the power supply. Short-circuits to ground will have magnitudes of approximately 30 mA and will not cause catastrophic failure at $T_A = 25^\circ\text{C}$.

Unintentional signal coupling from the output to the non-inverting input can cause oscillations. This is likely only in breadboard hook-ups with long component leads and can be prevented by a more careful lead dress or by locating the non-inverting input biasing resistor close to the IC. A quick check of this condition is to bypass the non-inverting input to ground with a capacitor. High impedance biasing resistors used in the non-inverting input circuit make this input lead highly susceptible to unintentional AC signal pickup.

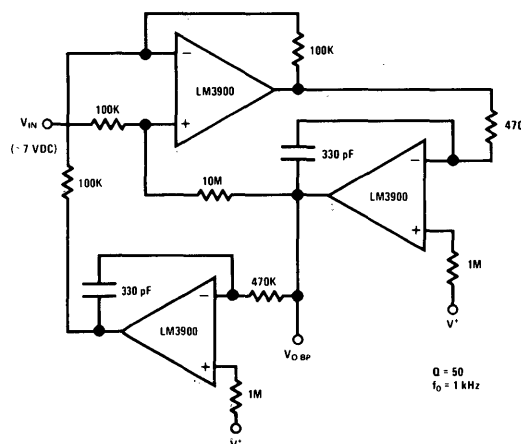
Operation of this amplifier can be best understood by noticing that input currents are differenced at the inverting-input terminal and this difference current then flows through the external feedback resistor to produce the output voltage. Common mode current biasing is generally useful to allow operating with signal levels near ground or even negative as this maintains the inputs biased at $+V_{BE}$. Internal clamp transistors (see note 5) catch negative input voltages at approximately -0.3 VDC but the magnitude of current flow has to be limited by the external input network. For operation at high temperature, this limit should be approximately 100 μA .

This new "Norton" current-differencing amplifier can be used in most of the applications of a standard IC op amp. Performance as a DC amplifier using only a single supply is not as precise as a standard IC op amp operating with split supplies but is adequate in many less critical applications. New functions are made possible with this amplifier which are useful in single power supply systems. For example, biasing can be designed separately from the AC gain as was shown in the "inverting amplifier", the "difference integrator" allows controlling the charging and the discharging of the integrating capacitor both with positive voltages, and the "frequency doubling tachometer" provides a simple circuit which reduces the ripple voltage on a tachometer output DC voltage.

typical applications (con't)

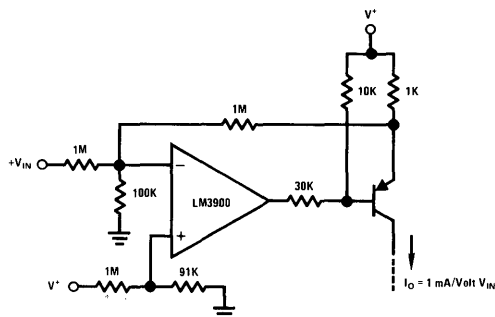
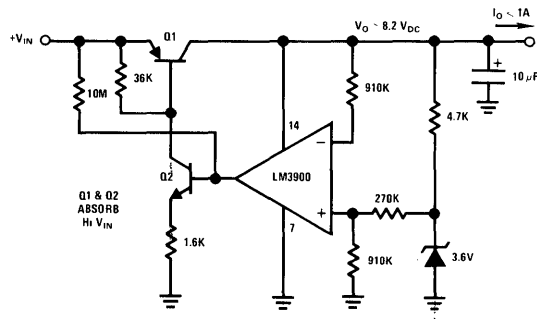
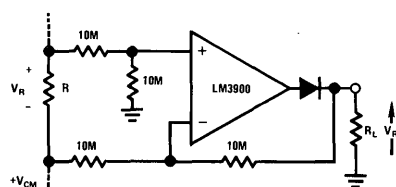
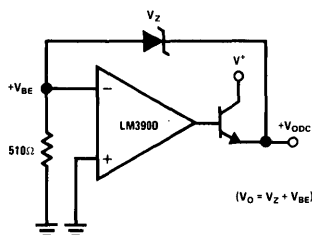


Low-Drift Ramp & Hold Circuit

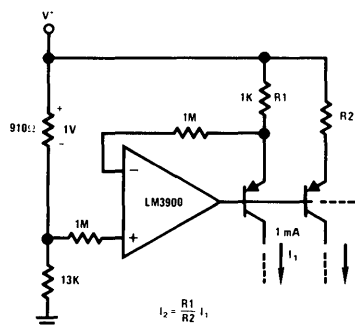


Bi-Quad Active Filter
(2nd Degree State-Variable Network)

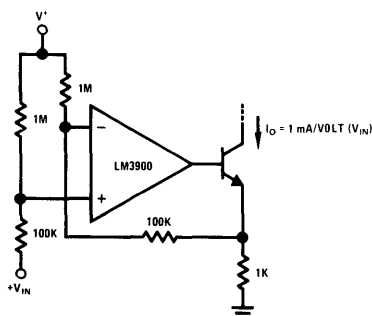
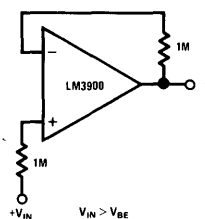
typical applications (con't)

Voltage-Controlled Current Source
(Transconductance Amplifier)Hi V_{IN} , Lo $(V_{IN} - V_O)$ Self-RegulatorGround-Referencing a
Differential Input Signal

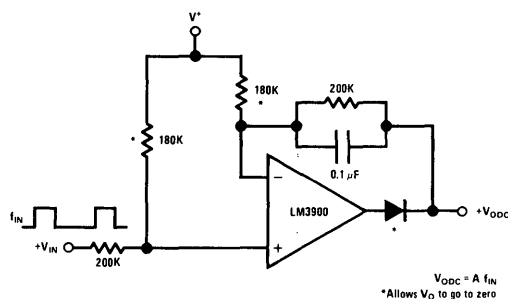
Voltage Regulator



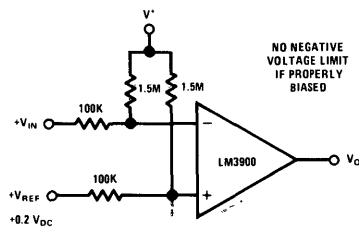
Fixed Current Sources

Voltage-Controlled Current Sink
(Transconductance Amplifier)

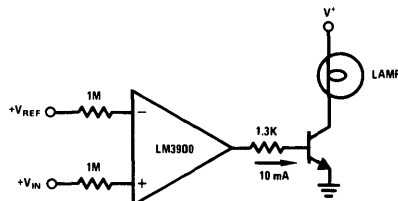
Buffer Amplifier



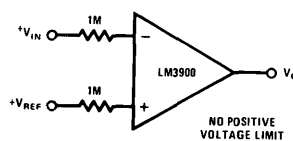
Tachometer



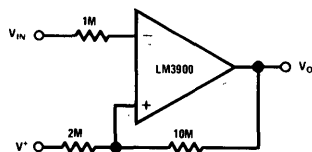
Low-Voltage Comparator



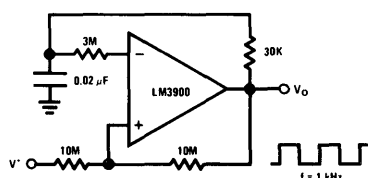
Power Comparator



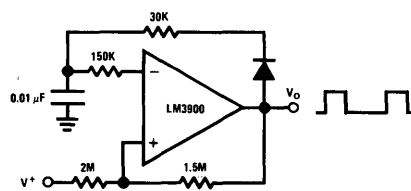
Comparator



Schmitt-Trigger

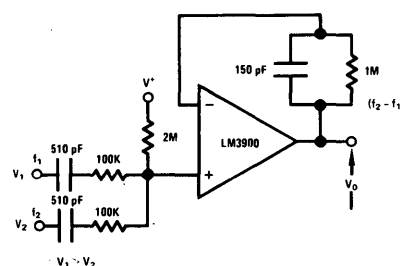
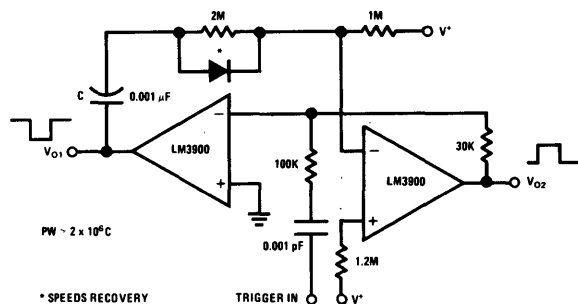
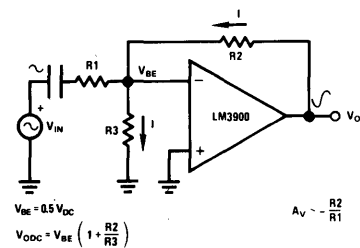
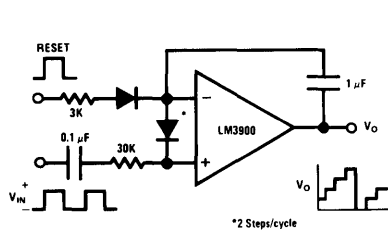
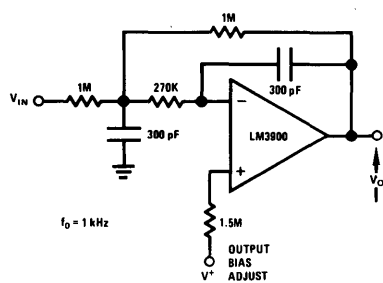
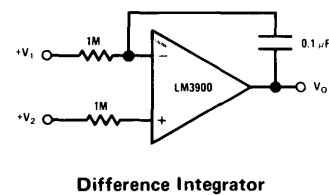
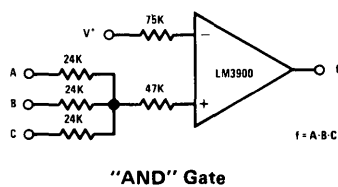
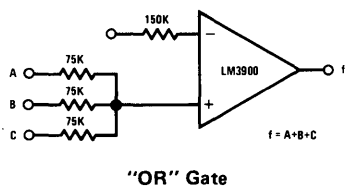
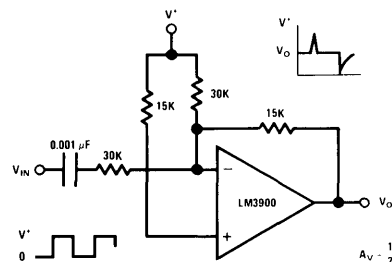
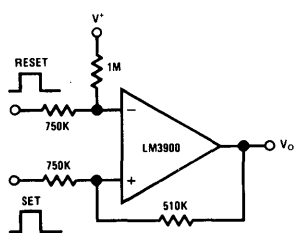
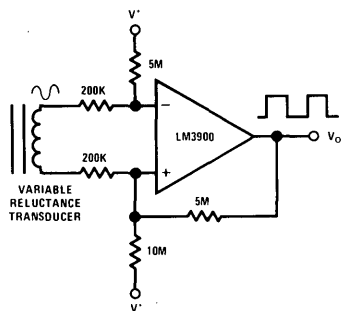
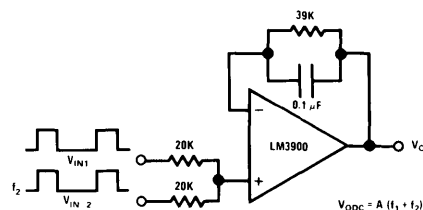
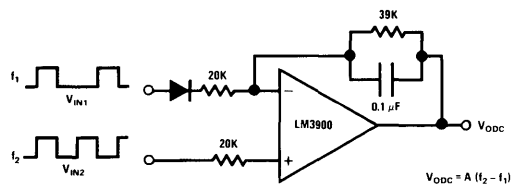


Square-Wave Oscillator

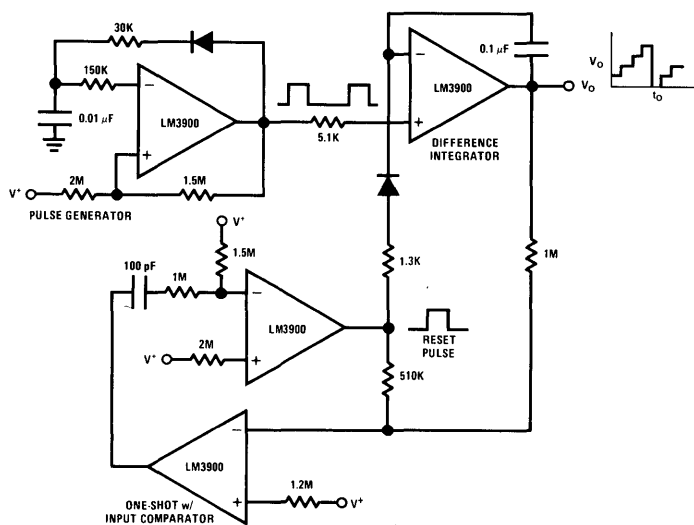


Pulse Generator

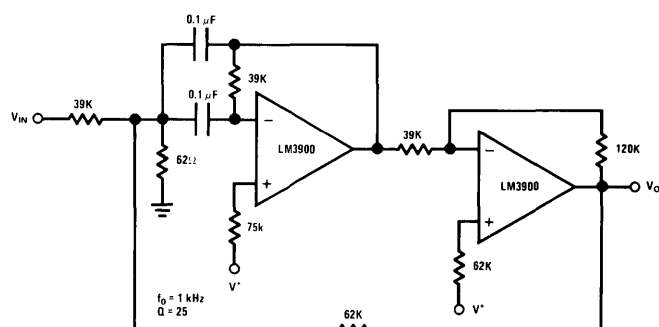
typical applications (con't)



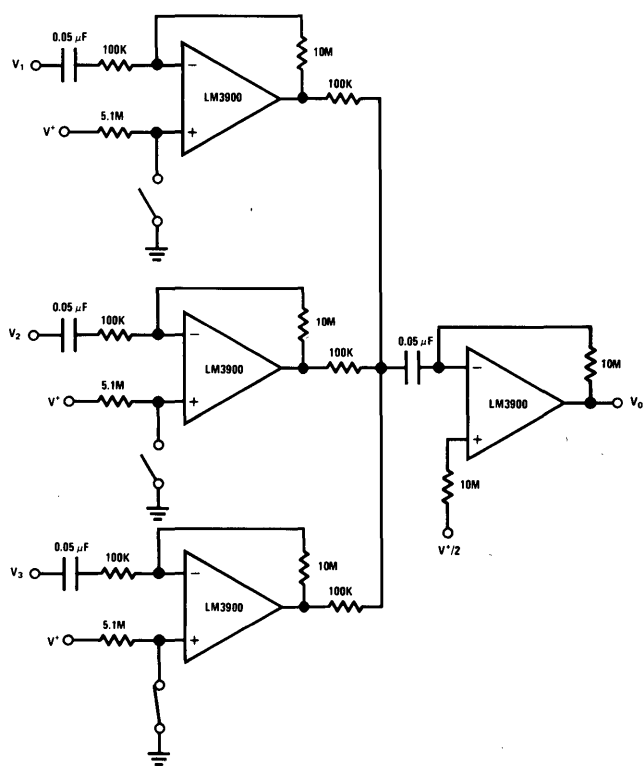
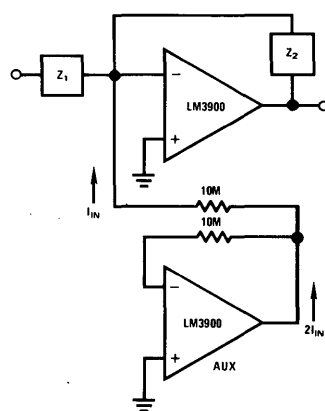
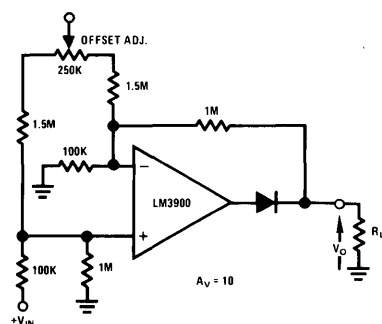
typical applications (con't)



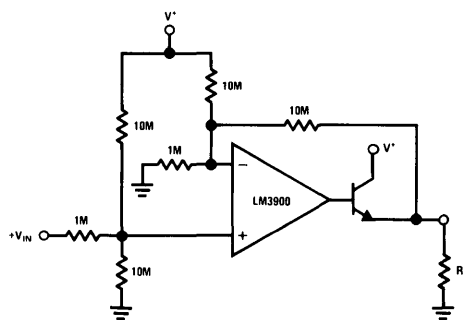
Free-Running Staircase Generator/Pulse Counter



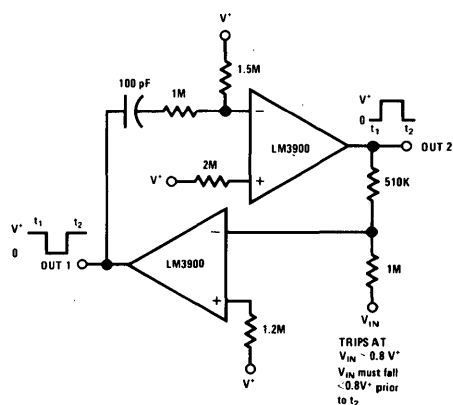
Bandpass Active Filter

Channel Selection by DC Control
(or Audio Mixer)Supplying I_{IN} with Aux. Amp
(to Allow High Z Feedback Networks)

Non-Inverting DC Gain to (0,0)

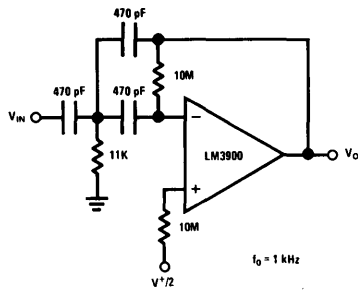


Power Amplifier

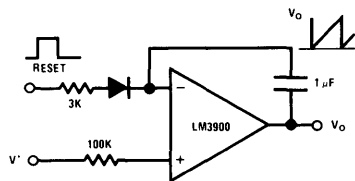


One-Shot w/ DC Input Comparator

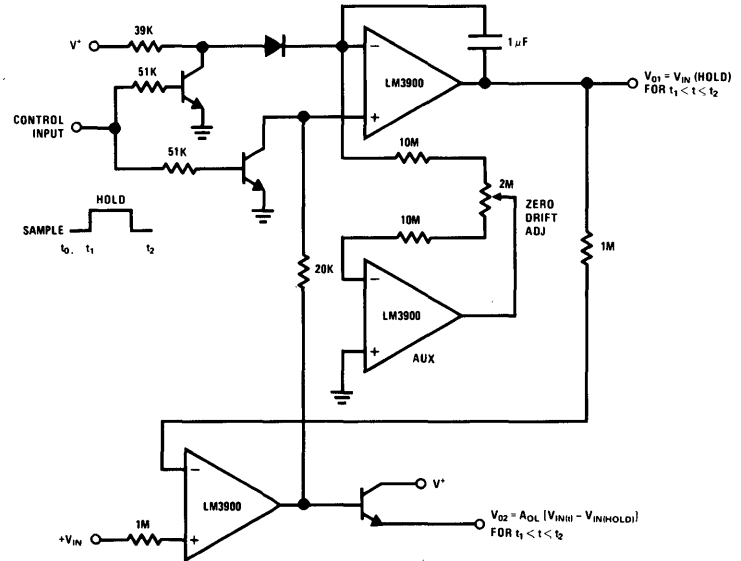
typical applications (con't)



High Pass Active Filter

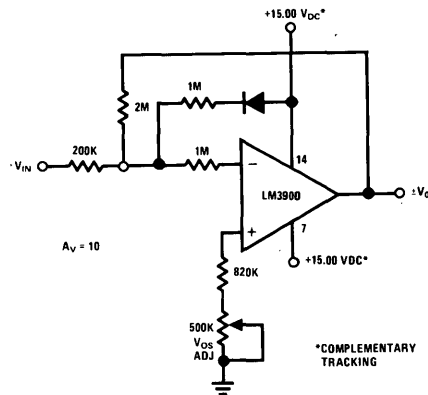


Sawtooth Generator

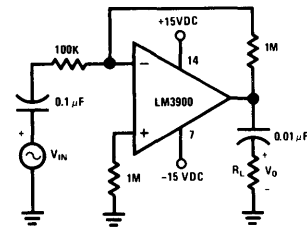


Sample-Hold & Compare with New $+V_{IN}$

split-supply applications ($V^+ = +15V_{DC}$ & $V^- = -15V_{DC}$)



Non-Inverting DC Gain



AC Amplifier