

# LM2900,LM3301,LM3900

*LM2900/LM3900/LM3301 Quad Amplifiers*



Literature Number: SNOSBV6

## LM2900/LM3900/LM3301 Quad Amplifiers

### General Description

The LM2900 series 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.

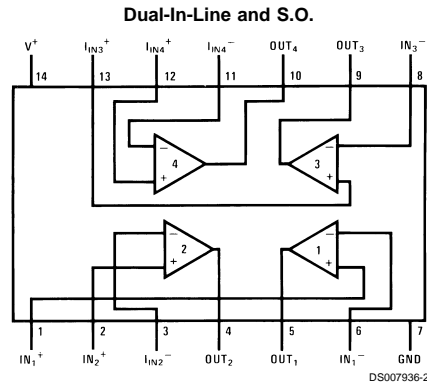
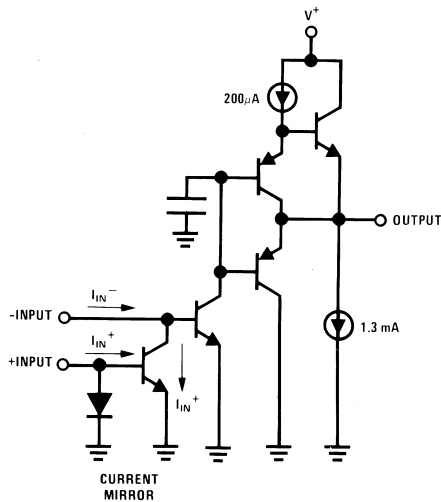
### Features

- Wide single supply voltage:  $4 V_{DC}$  to  $32 V_{DC}$

Range or dual supplies:  $\pm 2 V_{DC}$  to  $\pm 16 V_{DC}$

- 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



**Top View**  
Order Number LM2900N, LM3900M, LM3900N or LM3301N  
See NS Package Number M14A or N14A

## Absolute Maximum Ratings (Note 1)

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

	LM2900/LM3900	LM3301
Supply Voltage	32 V <sub>DC</sub> ±16 V <sub>DC</sub>	28 V <sub>DC</sub> ±14 V <sub>DC</sub>
Power Dissipation (T <sub>A</sub> = 25°C) (Note 2)		
Molded DIP	1080 mW	1080 mW
S.O. Package	765 mW	
Input Currents, I <sub>IN</sub> <sup>+</sup> or I <sub>IN</sub> <sup>-</sup>	20 mA <sub>DC</sub>	20 mA <sub>DC</sub>
Output Short-Circuit Duration — One Amplifier	Continuous	Continuous
T <sub>A</sub> = 25°C (See Application Hints)		
Operating Temperature Range		-40°C to +85°C
LM2900	-40°C to +85°C	
LM3900	0°C to +70°C	
Storage Temperature Range	-65°C to +150°C	-65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	260°C	260°C
Soldering Information		
Dual-In-Line Package		
Soldering (10 sec.)	260°C	260°C
Small Outline Package		
Vapor Phase (60 sec.)	215°C	215°C
Infrared (15 sec.)	220°C	220°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.		
ESD tolerance (Note 8)	2000V	2000V

## Electrical Characteristics

(Note 7) T<sub>A</sub> = 25°C, V<sup>+</sup> = 15 V<sub>DC</sub>, unless otherwise stated

Parameter		Conditions	LM2900			LM3900			LM3301			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Open Loop	Voltage Gain	Over Temp.										V/mV
	Voltage Gain	ΔV <sub>O</sub> = 10 V <sub>DC</sub>	1.2	2.8		1.2	2.8		1.2	2.8		
	Input Resistance	Inverting Input		1			1			1		MΩ
	Output Resistance			8			8			9		kΩ
Unity Gain Bandwidth		Inverting Input		2.5			2.5			2.5		MHz
Input Bias Current		Inverting Input, V <sup>+</sup> = 5 V <sub>DC</sub>		30	200		30	200		30	300	nA
Slew Rate		Positive Output Swing		0.5			0.5			0.5		V/μs
		Negative Output Swing		20			20			20		
Supply Current		R <sub>L</sub> = ∞ On All Amplifiers		6.2	10		6.2	10		6.2	10	mA <sub>DC</sub>
Output Voltage Swing	V <sub>OUT</sub> High	R <sub>L</sub> = 2k, V <sup>+</sup> = 15.0 V <sub>DC</sub>	I <sub>IN</sub> <sup>-</sup> = 0, I <sub>IN</sub> <sup>+</sup> = 0	13.5			13.5			13.5		V <sub>DC</sub>
	V <sub>OUT</sub> Low				0.09	0.2		0.09	0.2		0.09	
	V <sub>OUT</sub> High	V <sup>+</sup> = Absolute Maximum Ratings	I <sub>IN</sub> <sup>-</sup> = 0, I <sub>IN</sub> <sup>+</sup> = 0, R <sub>L</sub> = ∞,	29.5			29.5			26.0		
Output Current	Source		6	18		6	10		5	18		mA <sub>DC</sub>
	Sink	(Note 3)	0.5	1.3		0.5	1.3		0.5	1.3		
Capability	I <sub>SINK</sub>	V <sub>OL</sub> = 1V, I <sub>IN</sub> <sup>-</sup> = 5 μA		5			5			5		
Power Supply Rejection		T <sub>A</sub> = 25°C, f = 100 Hz		70			70			70		dB

## Electrical Characteristics (Continued)

(Note 7)  $T_A = 25^\circ\text{C}$ ,  $V^+ = 15 V_{DC}$ , unless otherwise stated

Parameter	Conditions	LM2900			LM3900			LM3301			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Mirror Gain	@ 20 $\mu\text{A}$ (Note 4)	0.90	1.0	1.1	0.90	1.0	1.1	0.90	1	1.10	$\mu\text{A}/\mu\text{A}$
	@ 200 $\mu\text{A}$ (Note 4)	0.90	1.0	1.1	0.90	1.0	1.1	0.90	1	1.10	
$\Delta$ Mirror Gain	@ 20 $\mu\text{A}$ to 200 $\mu\text{A}$ (Note 4)		2	5		2	5		2	5	%
Mirror Current	(Note 5)		10	500		10	500		10	500	$\mu\text{A}_{DC}$
Negative Input Current	$T_A = 25^\circ\text{C}$ (Note 6)		1.0			1.0			1.0		$\text{mA}_{DC}$
Input Bias Current	Inverting Input		300			300					nA

**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:** For operating at high temperatures, the device must be derated based on a  $125^\circ\text{C}$  maximum junction temperature and a thermal resistance of  $92^\circ\text{C}/\text{W}$  which applies for the device soldered in a printed circuit board, operating in a still air ambient. Thermal resistance for the S.O. package is  $131^\circ\text{C}/\text{W}$ .

**Note 3:** 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 4:** This spec indicates the current gain of the current mirror which is used as the non-inverting input.

**Note 5:** Input  $V_{BE}$  match between the non-inverting and the inverting inputs occurs for a mirror current (non-inverting input current) of approximately 10  $\mu\text{A}$ . This is therefore a typical design center for many of the application circuits.

**Note 6:** Clamp transistors are included on the IC to prevent the input voltages from swinging below ground more than approximately  $-0.3 V_{DC}$ . 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.

**Note 7:** These specs apply for  $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ , unless otherwise stated.

**Note 8:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

## 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  $+5 V_{DC}$  power supply at  $T_A = 25^\circ\text{C}$  with a 100 k $\Omega$  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 $\Omega$  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  $T_A = 25^\circ\text{C}$ .

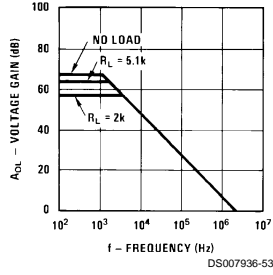
Unintentional signal coupling from the output to the non-inverting input can cause oscillations. This is likely only in breadboard hook-ups with long component leads and can be prevented by a more careful lead dress or by locating the non-inverting input biasing resistor close to the IC. A quick check 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 (Note 6) catch-negative input voltages at approximately  $-0.3 V_{DC}$  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  $\mu\text{A}$ .

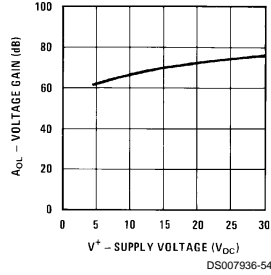
This new "Norton" current-differencing amplifier can be used in most of the applications of a standard IC op amp. Performance as a DC amplifier using only a single supply is not as precise as a standard IC op amp operating with split supplies but is adequate in many less critical applications. New functions 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 with positive voltages, and the "frequency doubling tachometer" provides a simple circuit which reduces the ripple voltage on a tachometer output DC voltage.

## Typical Performance Characteristics

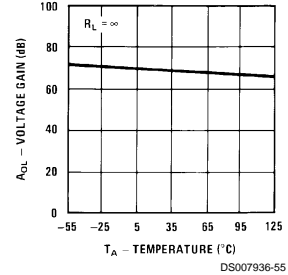
Open Loop Gain



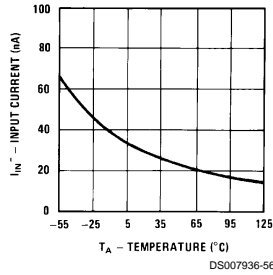
Voltage Gain



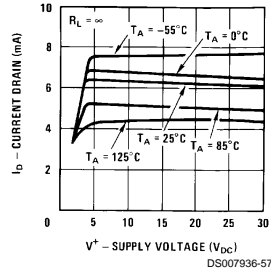
Voltage Gain



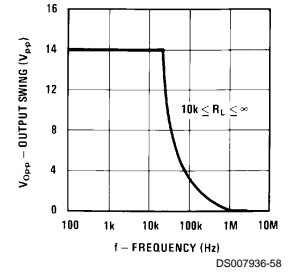
Input Current



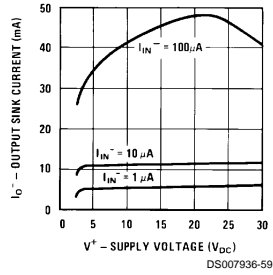
Supply Current



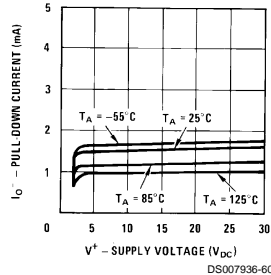
Large Signal Frequency Response



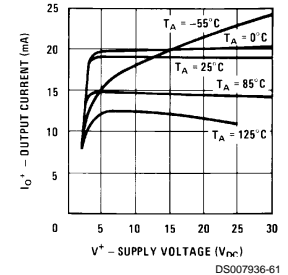
Output Sink Current



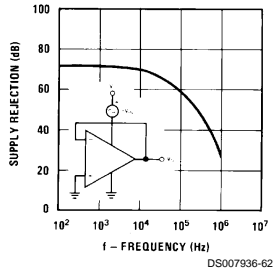
Output Class-A Bias Current



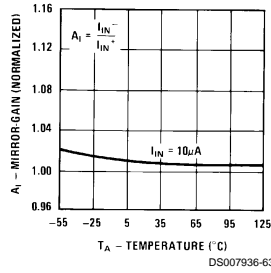
Output Source Current



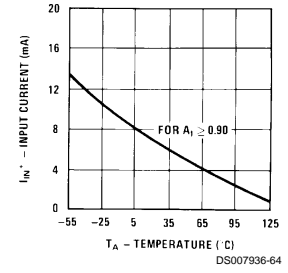
Supply Rejection



Mirror Gain

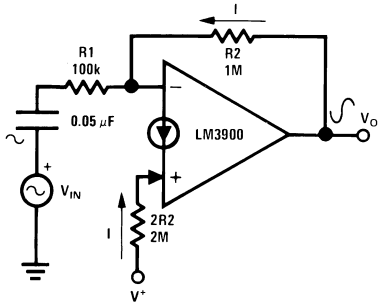


Maximum Mirror Current



## Typical Applications ( $V^+ = 15 V_{DC}$ )

### Inverting Amplifier

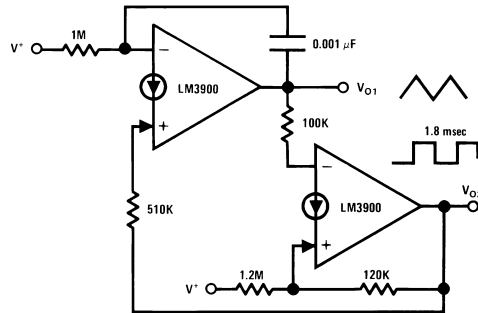


DS007936-3

$$V_{ODC} = \frac{V^+}{2}$$

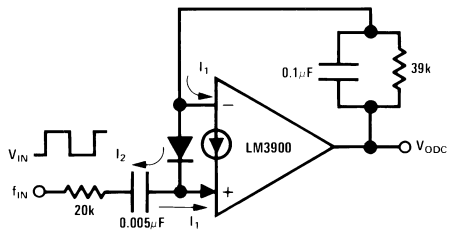
$$A_v \cong -\frac{R2}{R1}$$

### Triangle/Square Generator



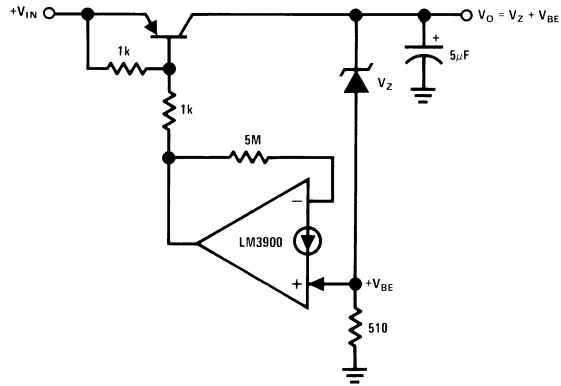
DS007936-4

### Frequency-Doubling Tachometer



DS007936-5

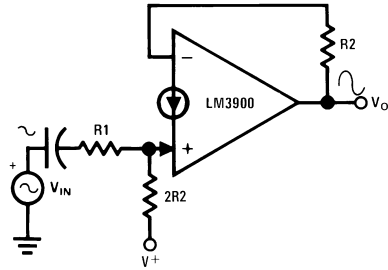
### Low $V_{IN} - V_{OUT}$ Voltage Regulator



DS007936-6

**Typical Applications** ( $V^+ = 15\text{ V}_{DC}$ ) (Continued)

**Non-Inverting Amplifier**

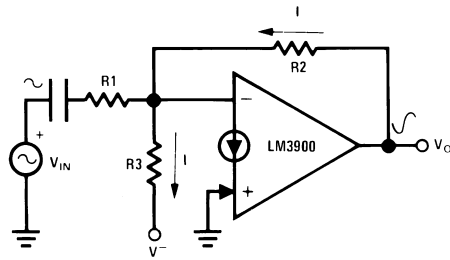


DS007936-7

$$V_{ODC} = \frac{V^+}{2}$$

$$A_V \cong \frac{R_2}{R_1}$$

**Negative Supply Biasing**

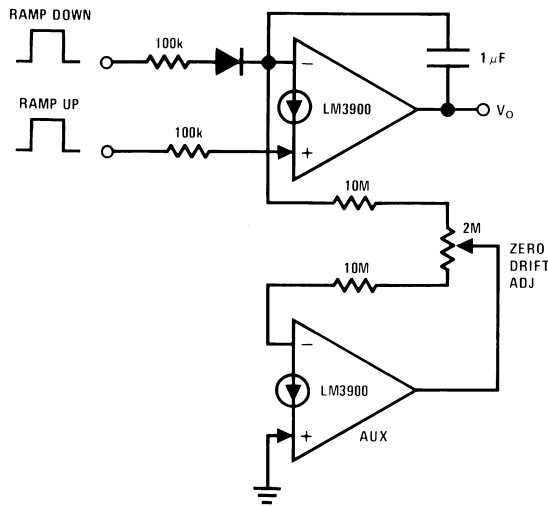


DS007936-8

$$V_{ODC} = \frac{R_2}{R_3} V^-$$

$$A_V \cong \frac{R_2}{R_1}$$

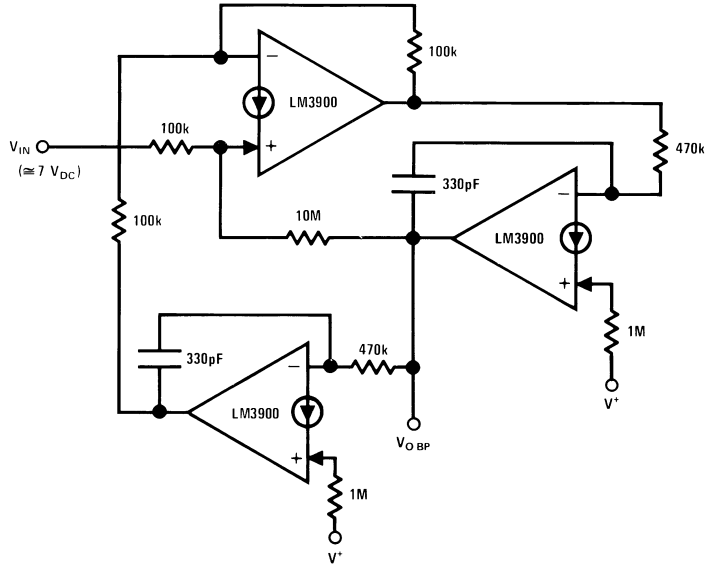
**Low-Drift Ramp and Hold Circuit**



DS007936-10

**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

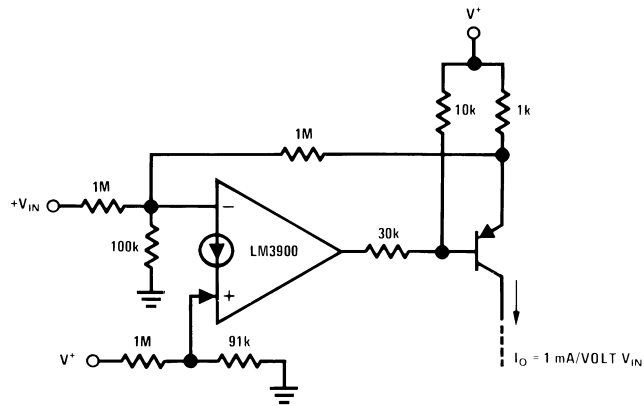
**Bi-Quad Active Filter**  
(2nd Degree State-Variable Network)



DS007936-11

$Q = 50$   
 $f_0 = 1 \text{ kHz}$

**Voltage-Controlled Current Source**  
(Transconductance Amplifier)

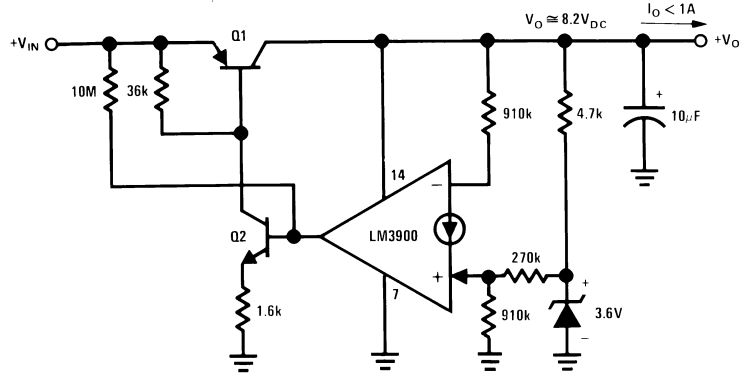


DS007936-12



**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

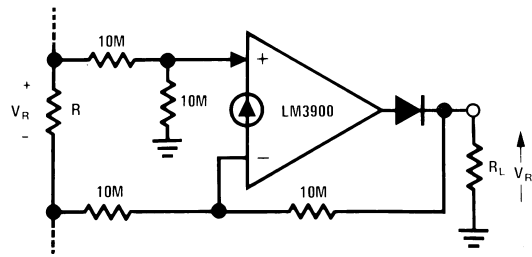
**Hi  $V_{IN}$ , Lo ( $V_{IN} - V_O$ ) Self-Regulator**



DS007936-13

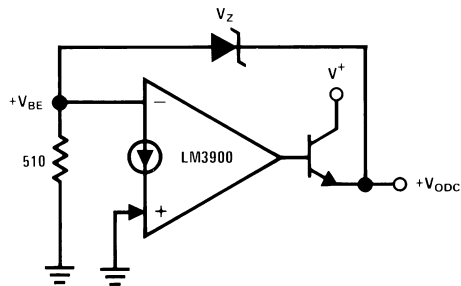
Q1 & Q2 absorb Hi  $V_{IN}$

**Ground-Referencing a Differential Input Signal**



DS007936-14

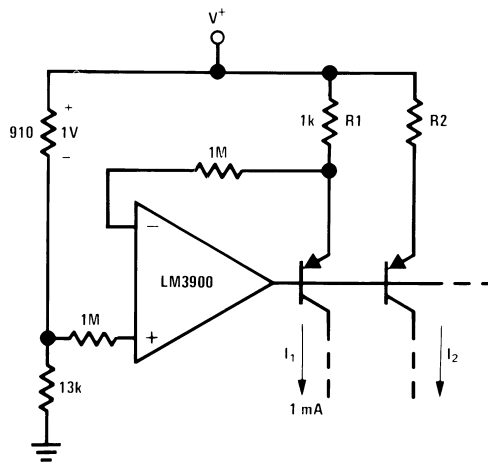
**Voltage Regulator**



DS007936-15

$(V_O = V_Z + V_{BE})$

**Fixed Current Sources**

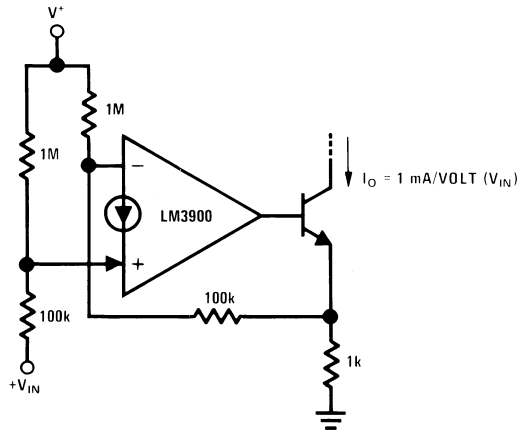


DS007936-16

$I_2 = \frac{R_1}{R_2} I_1$

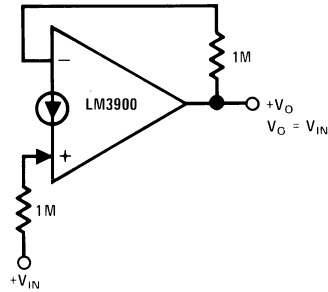
## Typical Applications ( $V^+ = 15\text{ V}_{DC}$ ) (Continued)

### Voltage-Controlled Current Sink (Transconductance Amplifier)



DS007936-17

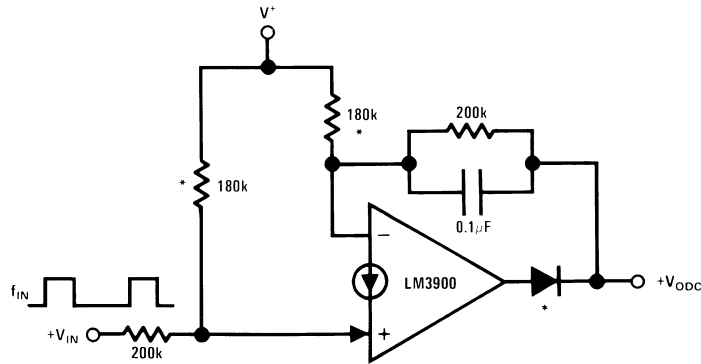
### Buffer Amplifier



DS007936-18

$V_{IN} \geq V_{BE}$

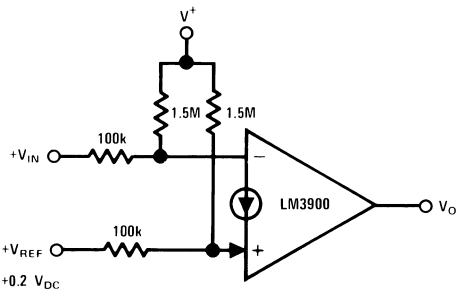
### Tachometer



DS007936-19

$V_{ODC} = A f_{IN}$   
\* Allows  $V_O$  to go to zero.

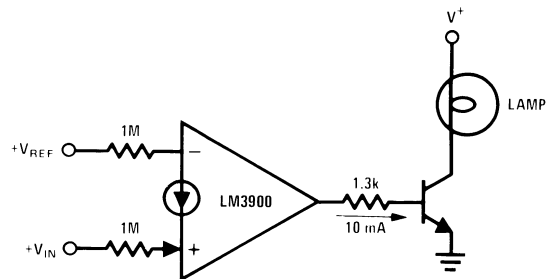
### Low-Voltage Comparator



DS007936-20

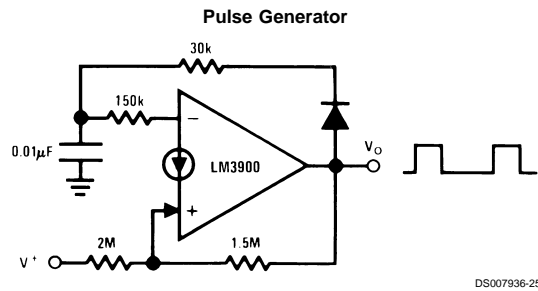
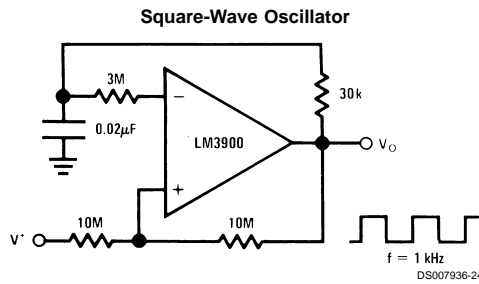
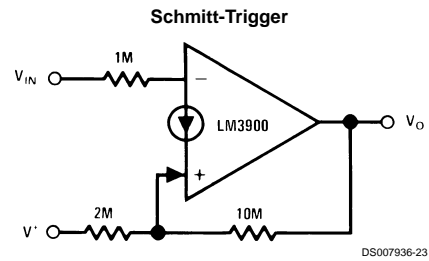
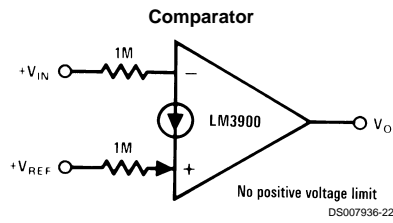
No negative voltage limit if properly biased.

### Power Comparator

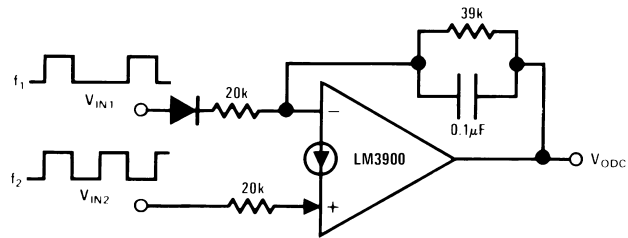


DS007936-21

## Typical Applications ( $V^+ = 15 V_{DC}$ ) (Continued)

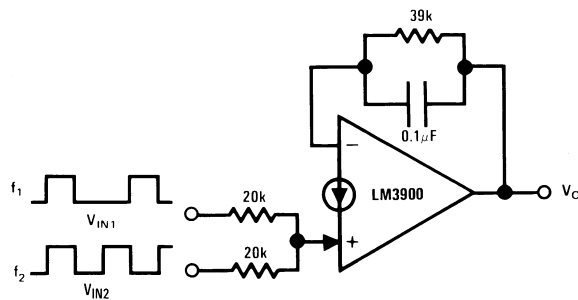


### Frequency Differencing Tachometer



$$V_{Odc} = A(f_1 - f_2)$$

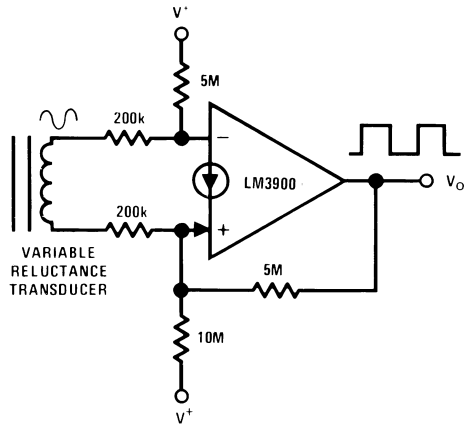
### Frequency Averaging Tachometer



$$V_{Odc} = A(f_1 + f_2)$$

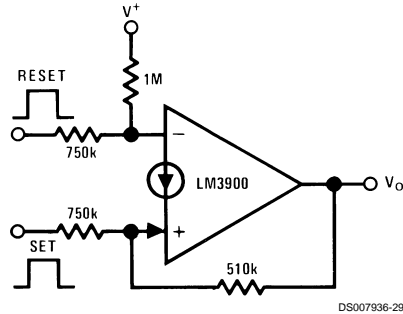
## Typical Applications ( $V^+ = 15\text{ V}_{DC}$ ) (Continued)

### Squaring Amplifier (W/Hysteresis)



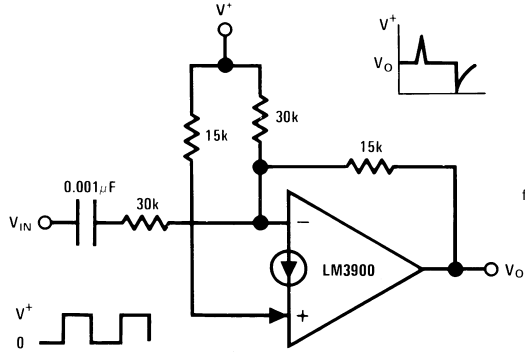
DS007936-28

### Bi-Stable Multivibrator



DS007936-29

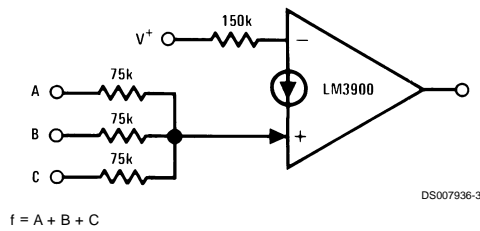
### Differentiator (Common-Mode Biasing Keeps Input at $+V_{BE}$ )



DS007936-30

$$A_V = \frac{1}{2}$$

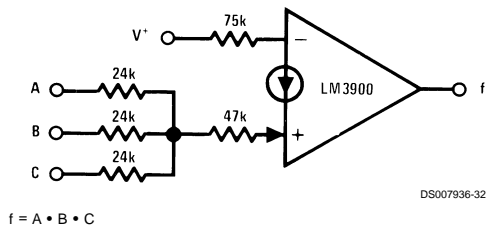
### "OR" Gate



DS007936-31

$$f = A + B + C$$

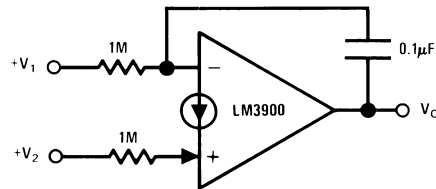
### "AND" Gate



DS007936-32

$$f = A \cdot B \cdot C$$

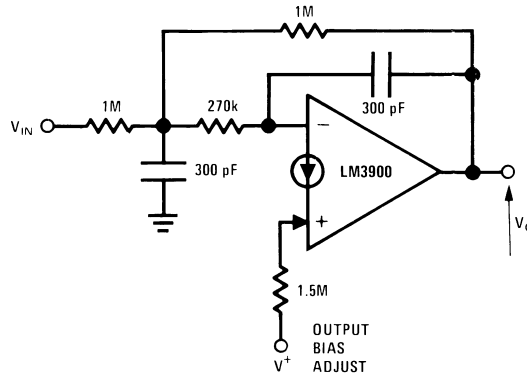
### Difference Integrator



DS007936-33

**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

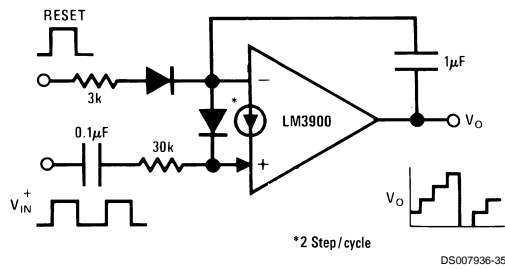
**Low Pass Active Filter**



DS007936-34

$f_0 = 1 \text{ kHz}$

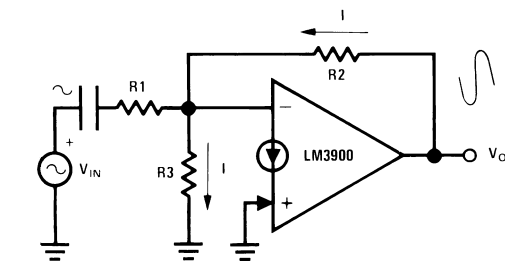
**Staircase Generator**



\*2 Step / cycle

DS007936-35

**$V_{BE}$  Biasing**



$$V_{BE} = 0.5 V_{DC}$$

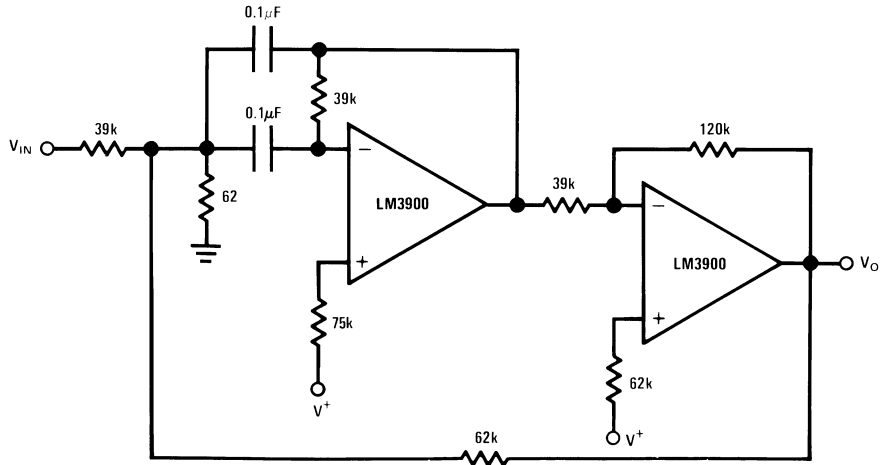
$$V_{ODC} = V_{BE} \left( 1 + \frac{R2}{R3} \right)$$

DS007936-36

$$A_V \approx - \frac{R2}{R1}$$

**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

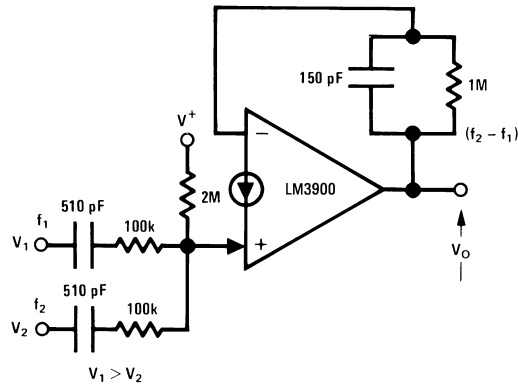
**Bandpass Active Filter**



DS007936-37

$f_0 = 1 \text{ kHz}$   
 $Q = 25$

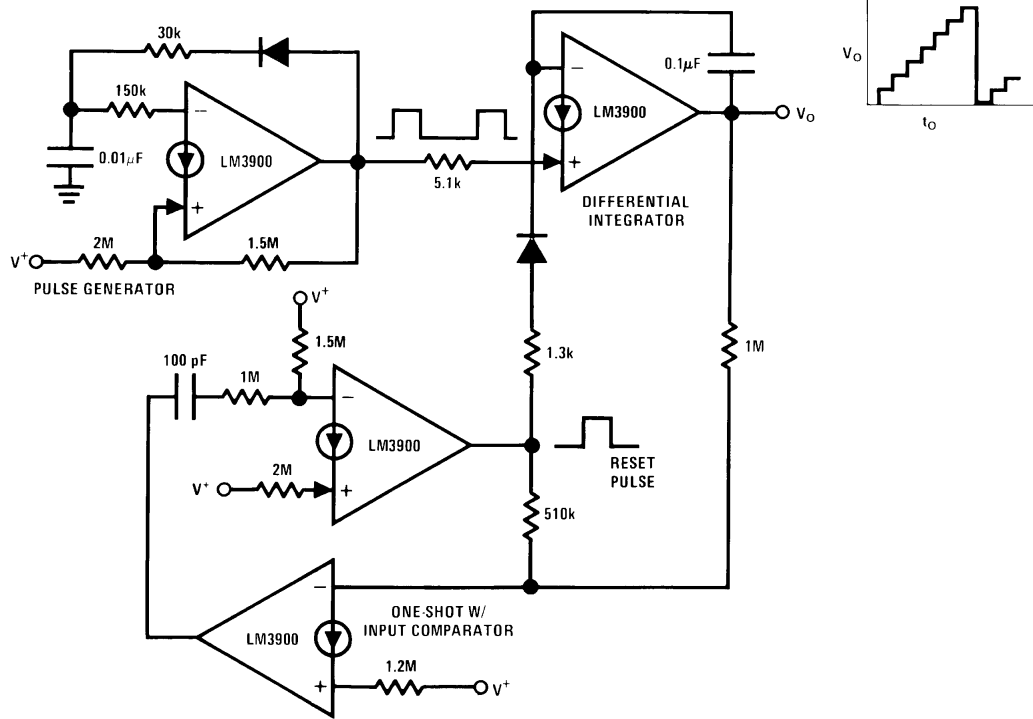
**Low-Frequency Mixer**



DS007936-38

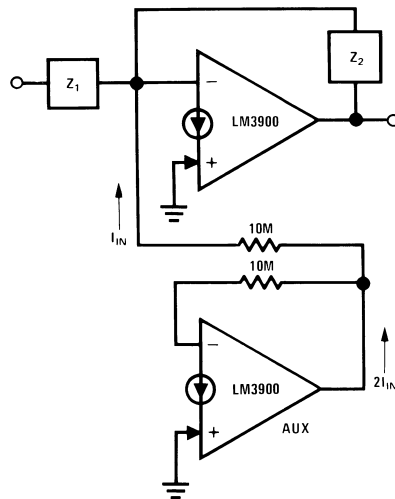
Typical Applications ( $V^+ = 15 V_{DC}$ ) (Continued)

Free-Running Staircase Generator/Pulse Counter



DS007936-39

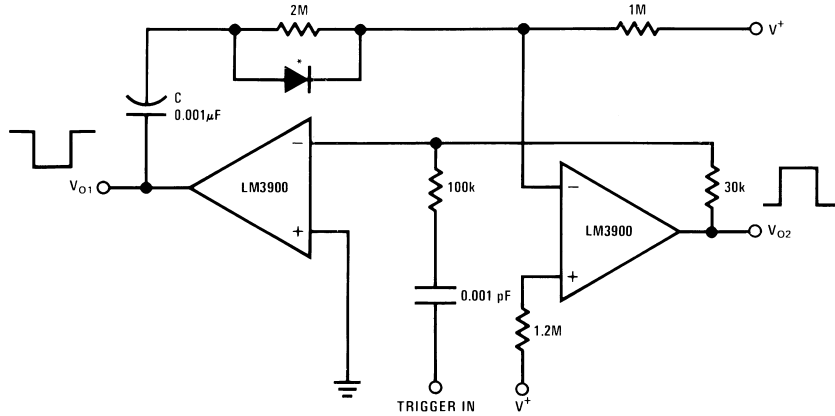
Supplying  $I_{IN}$  with Aux. Amp  
(to Allow Hi-Z Feedback Networks)



DS007936-40

**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

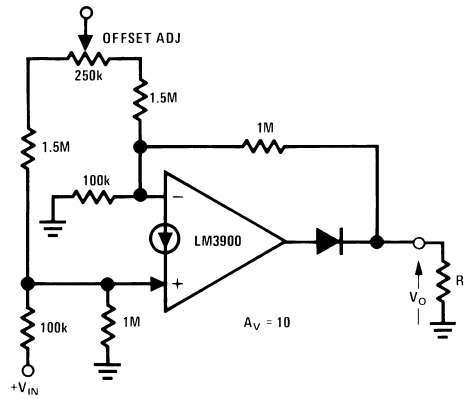
**One-Shot Multivibrator**



DS007936-41

$PW \cong 2 \times 10^6 C$   
 \* Speeds recovery.

**Non-Inverting DC Gain to (0,0)**

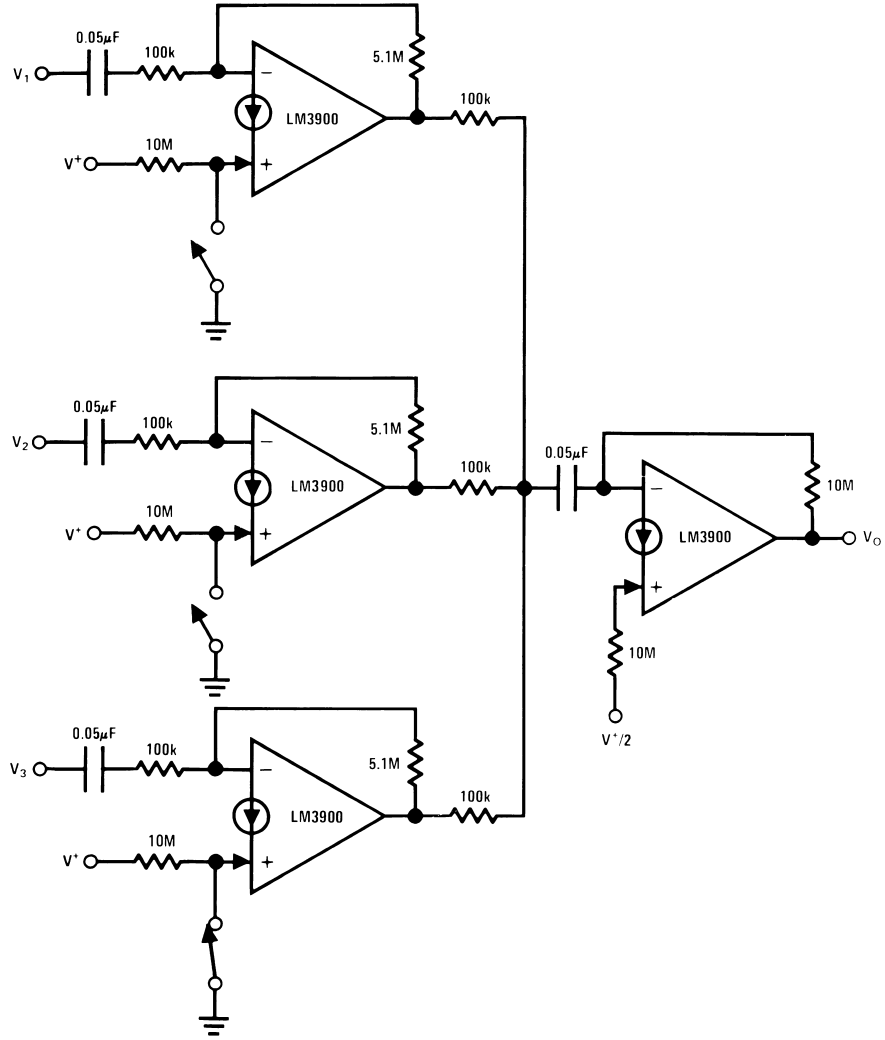


DS007936-42



Typical Applications ( $V^+ = 15 V_{DC}$ ) (Continued)

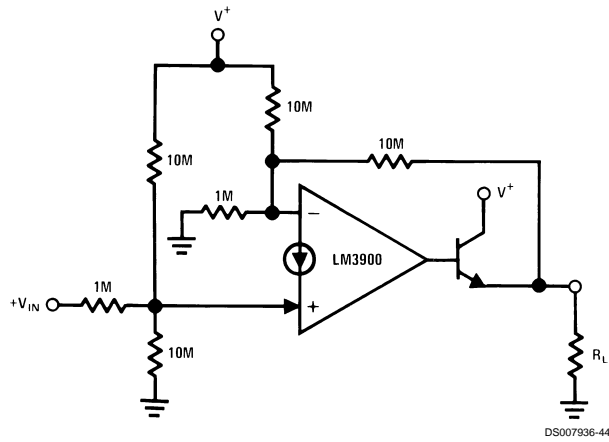
Channel Selection by DC Control (or Audio Mixer)



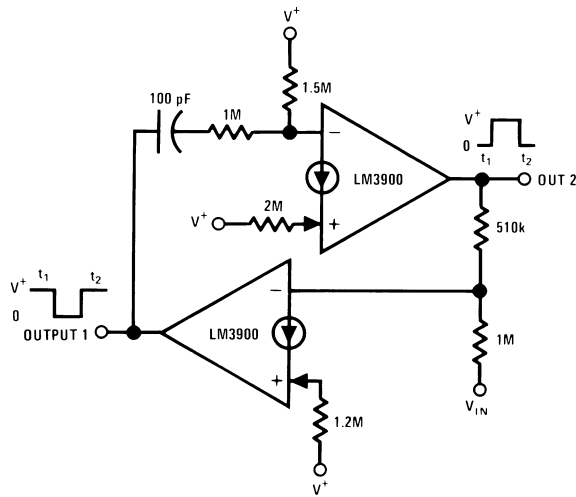
DS007936-43

**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

**Power Amplifier**

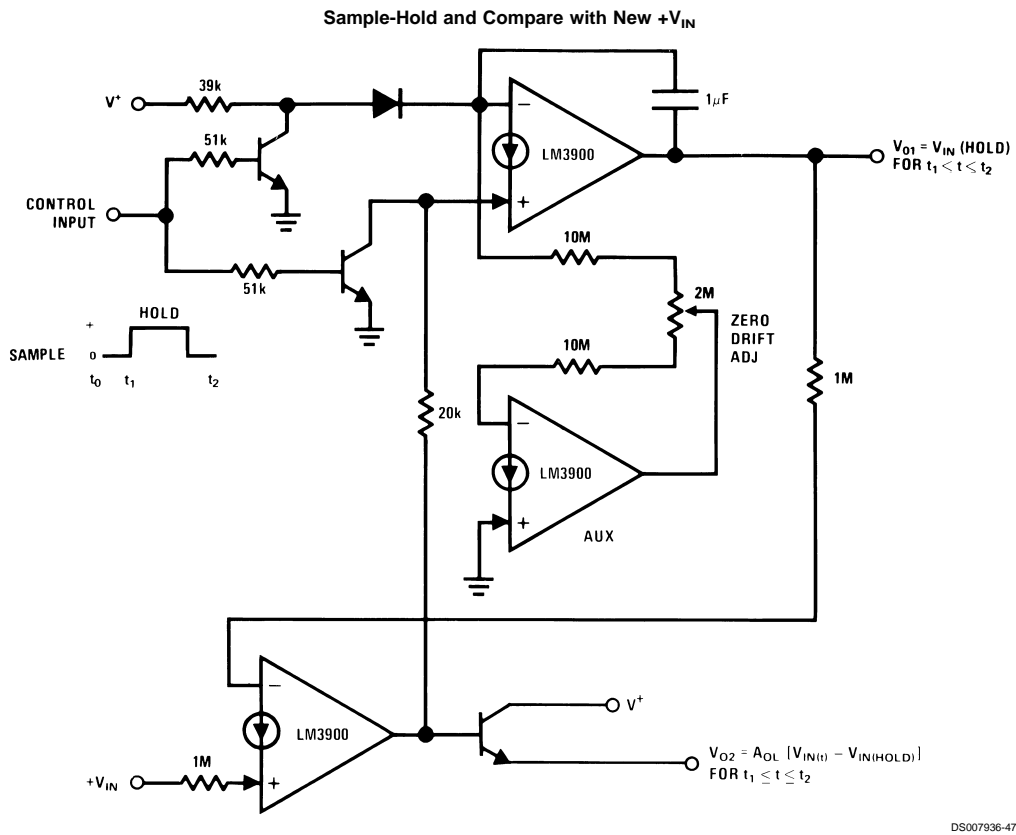
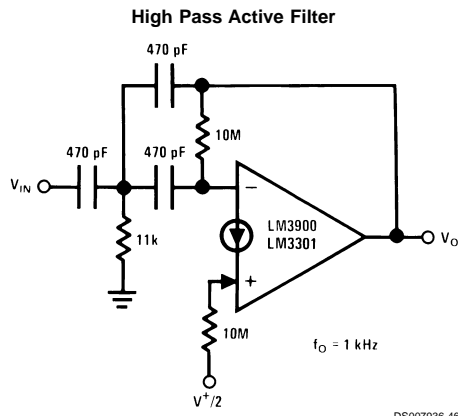


**One-Shot with DC Input Comparator**



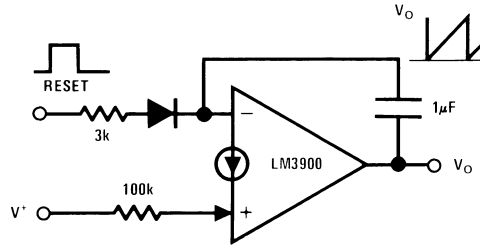
Trips at  $V_{IN} \cong 0.8 V^+$   
 $V_{IN}$  must fall  $0.8 V^+$  prior to  $t_2$

Typical Applications ( $V^+ = 15 V_{DC}$ ) (Continued)



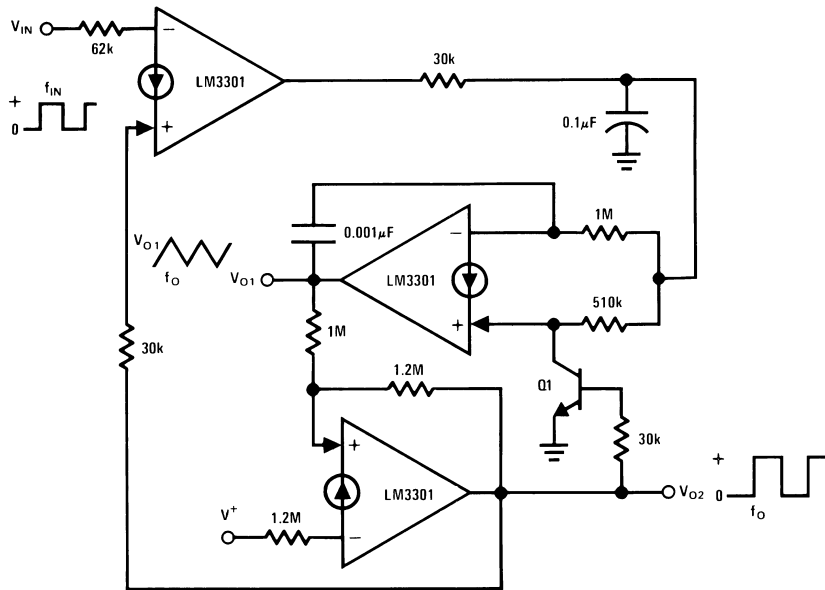
**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

**Sawtooth Generator**



DS007936-48

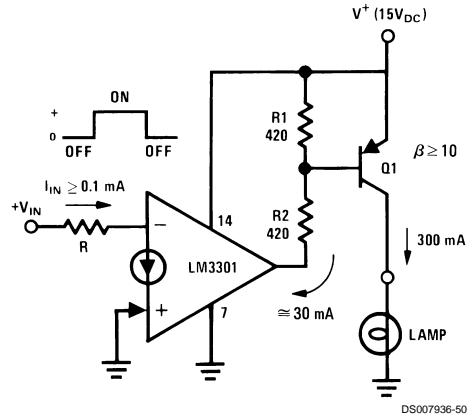
**Phase-Locked Loop**



DS007936-49

**Typical Applications** ( $V^+ = 15 V_{DC}$ ) (Continued)

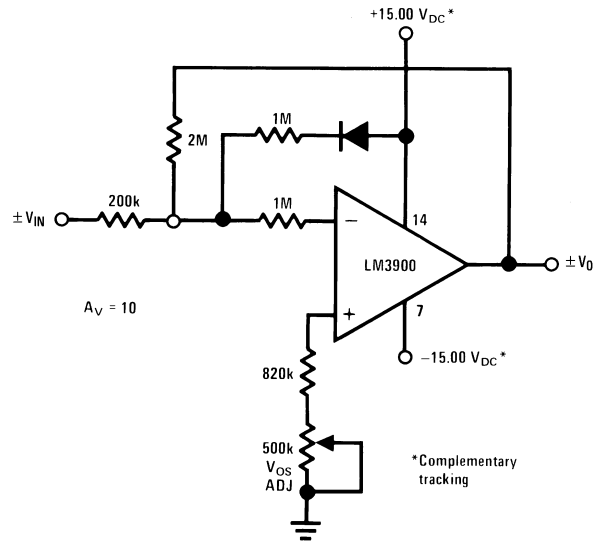
**Boosting to 300 mA Loads**



DS007936-50

**Split-Supply Applications** ( $V^+ = +15 V_{DC}$  &  $V^- = -15 V_{DC}$ )

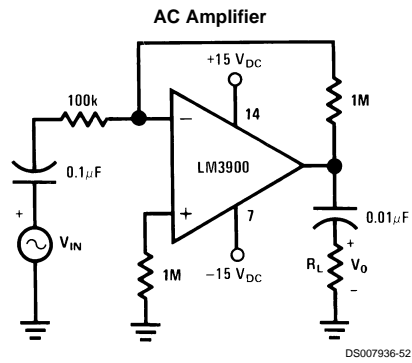
**Non-Inverting DC Gain**



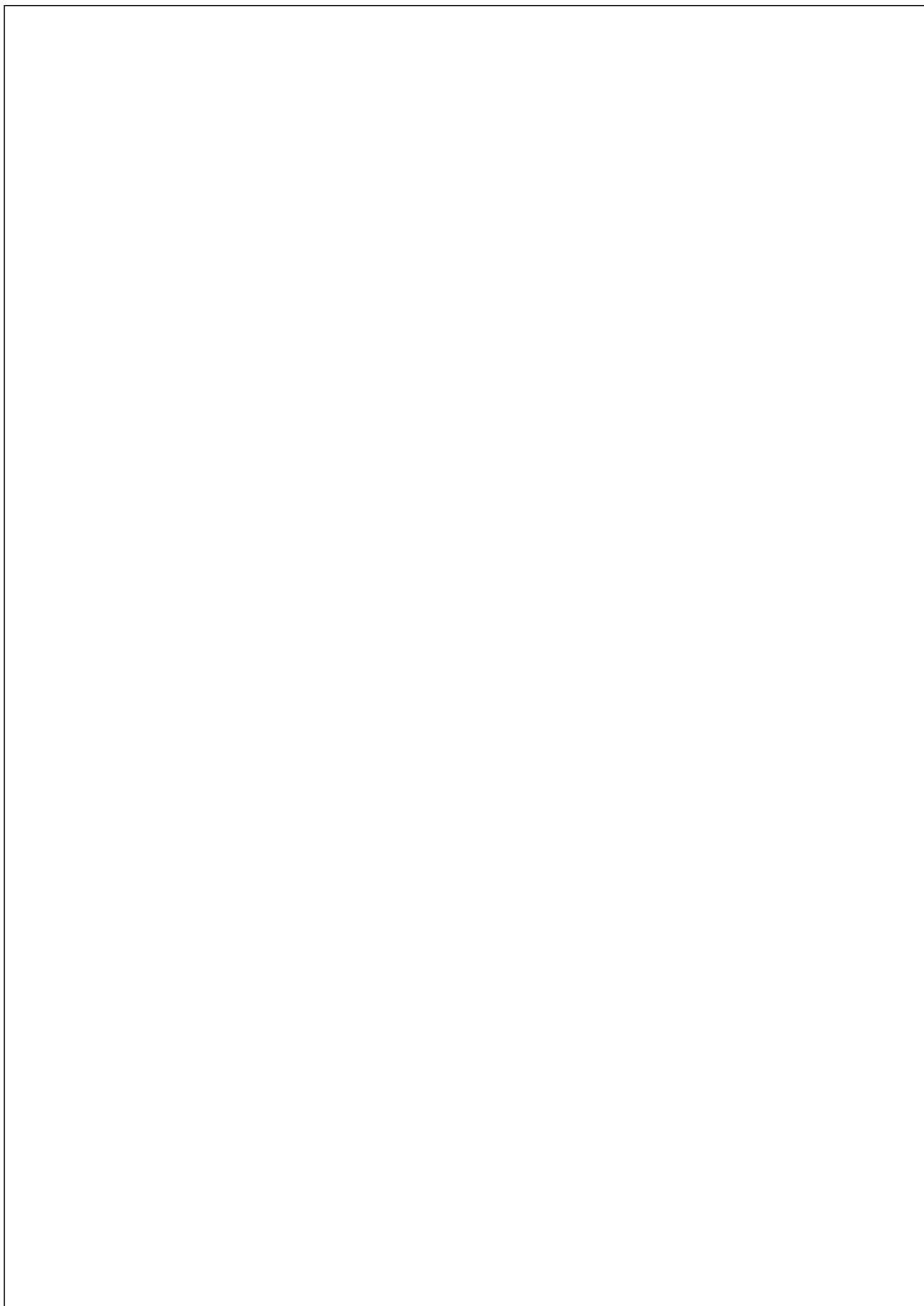
DS007936-51

Book  
Extract  
End

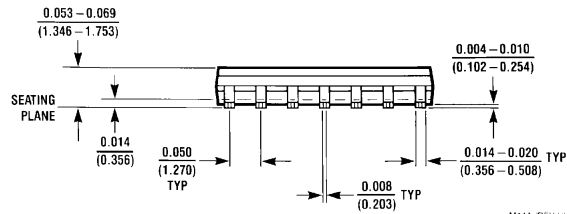
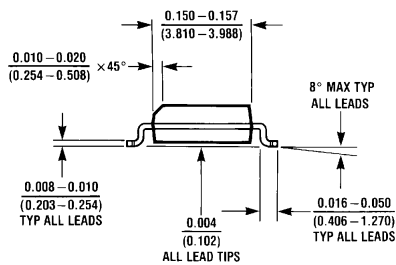
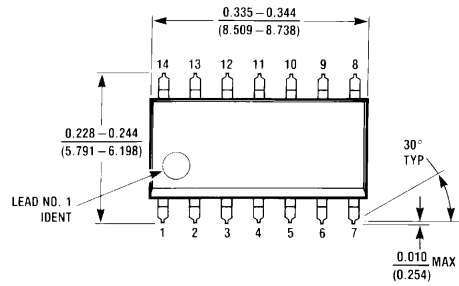
**Split-Supply Applications** ( $V^+ = +15 V_{DC}$  &  $V^- = -15 V_{DC}$ ) (Continued)



Book  
Extract  
End

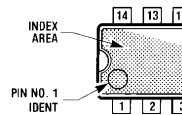
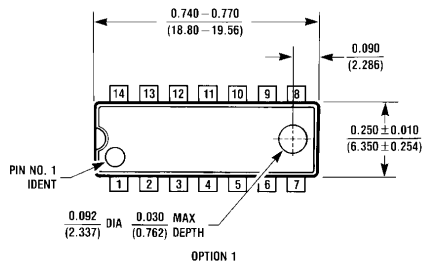


**Physical Dimensions** inches (millimeters) unless otherwise noted



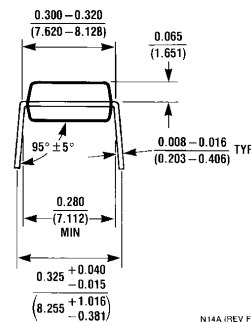
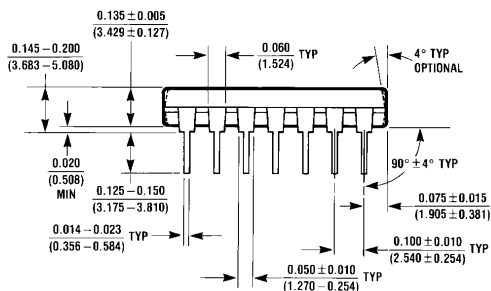
M14A (REV H)

**Small Outline Package (M)**  
**Order Number LM3900M**  
**NS Package Number M14A**



OPTION 1

OPTION 2



N14A (REV F)


**Molded Dual-In-Line Package (N)**  
**Order Number LM2900N, LM3900N or LM3301N**  
**NS Package Number N14A**



**LIFE SUPPORT POLICY**

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in 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.

 <p><b>National Semiconductor Corporation</b> Americas Tel: 1-800-272-9959 Fax: 1-800-737-7018 Email: support@nsc.com</p> <p>www.national.com</p>	<p><b>National Semiconductor Europe</b></p> <p>Fax: +49 (0) 1 80-530 85 86 Email: europe.support@nsc.com</p> <p>Deutsch Tel: +49 (0) 1 80-530 85 85 English Tel: +49 (0) 1 80-532 78 32 Français Tel: +49 (0) 1 80-532 93 58 Italiano Tel: +49 (0) 1 80-534 16 80</p>	<p><b>National Semiconductor Asia Pacific Customer Response Group</b></p> <p>Tel: 65-2544466 Fax: 65-2504466 Email: sea.support@nsc.com</p>	<p><b>National Semiconductor Japan Ltd.</b></p> <p>Tel: 81-3-5620-6175 Fax: 81-3-5620-6179</p>
--	---	---	--

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Transportation and Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2011, Texas Instruments Incorporated