



Description

The LM321 brings performance and economy to low power systems. With a high unity gain frequency and a guaranteed $0.4\text{V}/\mu\text{s}$ slew rate, the quiescent current is only $100\mu\text{A}(5\text{V})$. The input common mode range includes ground and therefore the device is able to operate in single supply applications as well as in dual supply applications. It is also capable of comfortably driving large capacitive loads.

Overall the LM321 is a low power, wide supply range performance op amp that can be designed into a wide range of applications at an economical price without sacrificing valuable board space .

The LM321 is available in the SOT-23-5L package.

Features

- Gain-Bandwidth product 1.0MHz
- Low supply current $100\mu\text{A}$
- Low input bias current 45nA
- Wide supply voltage range $+3\text{V}$ o $+32\text{V}$

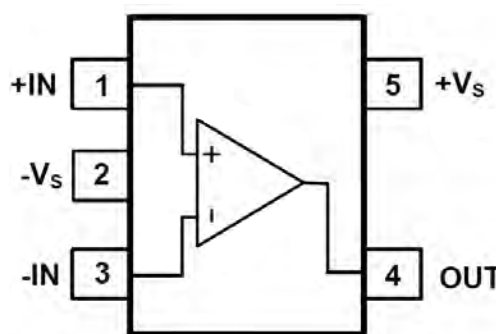
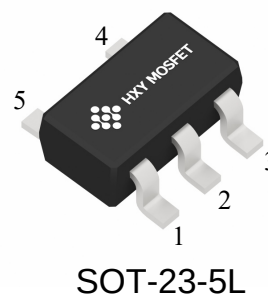
Applications

- Chargers
- Power supplies
- Industrial controls and
- instruments Desktops
- Communications infrastructure

Ordering Information

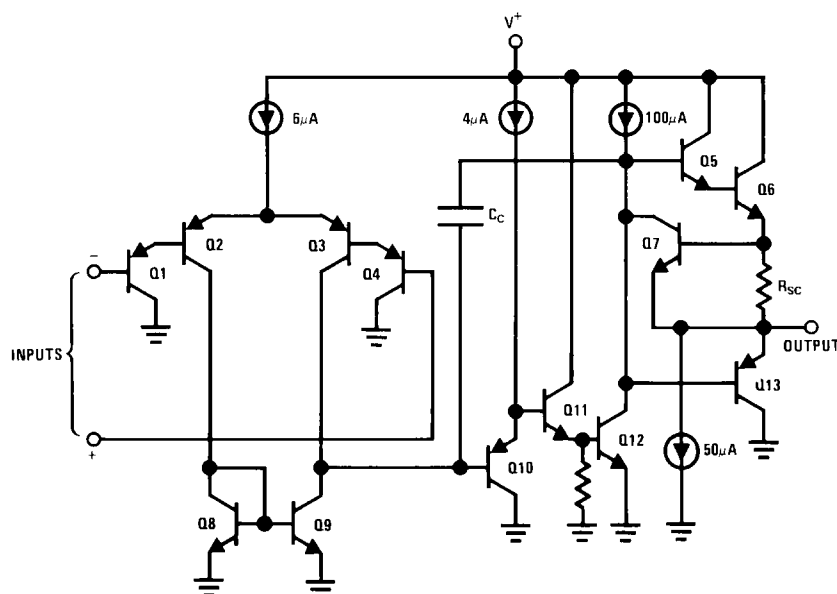
Product Model	Package Type	Brand	Packing	Packing Qty
LM321	SOT-23-5L	HXY MOSFET	Tape	3000Pcs/Reel

Pin Configuration





Simplified Schematic



Absolute Maximum Ratings

Parameter Name	Value	Unit
Supply Voltage	32	V
Input Voltage	-0.3~+32	V
Output Short Circuit to GNDV ⁺ ≤15V and Ta=25°C *Note 2	Continuous	
Junction Temperature *Note 3	150	°C
Thermal Resistance to Ambient (θJA)	265	°C/W
Operating Temperature Range	-40~+85	°C
Storage Temperature Range	-65~+150	°C

Operating Conditions

Symbol	Parameter	Value	Unit
V _{CC}	Supply voltage	3 ~ 30	V
T _{oper}	Operating free air temperature range	-40 ~ +85	°C



Electrical Characteristics

Parameter Name		Test Conditions		Min	Typ	Max	Unit
Input Offset Voltage		Ta=25 °C *Note 4			2	5	mV
Input Bias Current		Ta=25°C, I _{IN(+)} or I _{IN(-)} , V _{CM} =0V *Note 5			45	150	nA
Input Offset Current		Ta=25°C, I _{IN(+)} - I _{IN(-)} , V _{CM} =0V			3	30	nA
Input Common-Mode Voltage Range		Ta=25°C, V ⁺ =30V *Note 6		0		V ⁺ -1.5	V
Supply Current		Over Full Temperature Range, R _L =∞ on all Op Amps	V ⁺ =30V		160	500	μA
			V ⁺ =5V		100	300	
Large Signal Voltage Gain		Ta=25°C, V ⁺ =15V, R _L ≥2kΩ (for Vo=1~11V)		50	100		V/mV
Common-Mode Rejection Ratio		DC, Ta=25°C, V _{CM} =0~V ⁺ -1.5V		70	90		dB
Power Supply Rejection Ratio		DC, Ta=25°C, V ⁺ =5~30V		75	100		dB
Amplifier-to-Amplifier Coupling		Ta=25°C, f=1~20kHz (input referred)*Note 7			-120		dB
Output Current	Source	V _{IN(+)} =1V, V _{IN(-)} =0V, V ⁺ =15V, Vo=2V, Ta=25°C		20	40		mA
	Sink	V _{IN(-)} =1V, V _{IN(+)} =0V, V ⁺ =15V, Vo=2V, Ta=25°C			15		mA
		V _{IN(-)} =1V, V _{IN(+)} =0V, V ⁺ =15V, Vo=200mV, Ta=25°C			50		μA
Short Circuit to Ground		Ta=25°C, V ⁺ =15V *Note 2			40	85	mA
Output Voltage Swing	V _{OH}	V ⁺ =30V	R _L =2kΩ	21	23		V
			R _L =10kΩ	22	24		V
	V _{OL}	V ⁺ =5V, R _L =10kΩ			5	20	mV

* 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: Short circuits from the output to V⁺ can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 40mA independent of the magnitude of V⁺. At values of supply voltage in excess of +15V, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

* Note 3: The maximum power dissipation is a function of T_{J(MAX)}, θ_{JA}, and Ta. The maximum allowable power dissipation at any ambient temperature is PD = (T_{J(MAX)} - Ta) / θ_{JA}. All numbers apply for packages soldered directly onto a PC board.



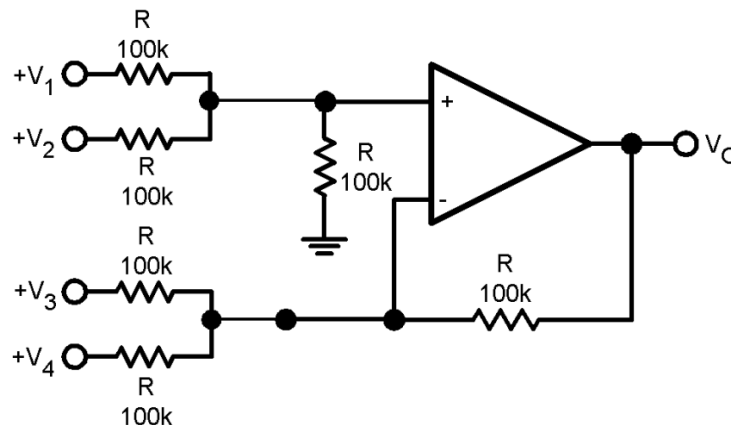
* Note 4: $V_o=1.4V$, $R_s = 0\Omega$ with V from 5V to 30V; and over the full input common-mode range (0V to $V^+-1.5V$) at 25°C.

* Note 5: 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 6: The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of them common-mode voltage range is $V^+-1.5V$ (at 25°C), but either or both inputs can go to +32V without damage, independent of the magnitude of V^+ .

* Note 7: Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

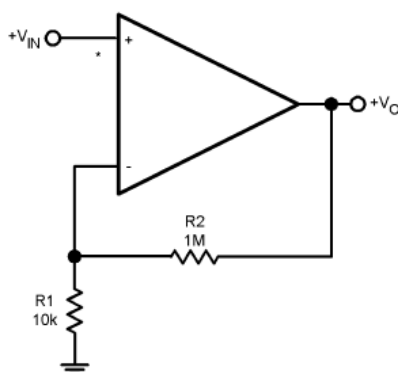
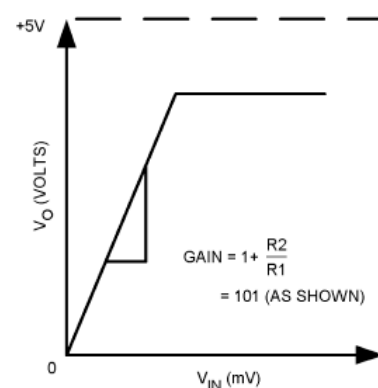
Typical Application



Where: $V_o = V_1 + V_2 - V_3 - V_4$, $(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_o \geq 0V_{DC}$

DC Summing Amplifier

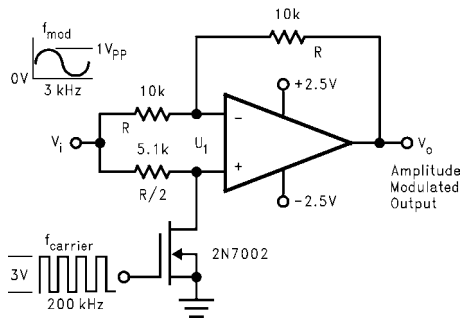
($V_{IN's} \geq 0V_{DC}, V_o \geq V_{DC}$)



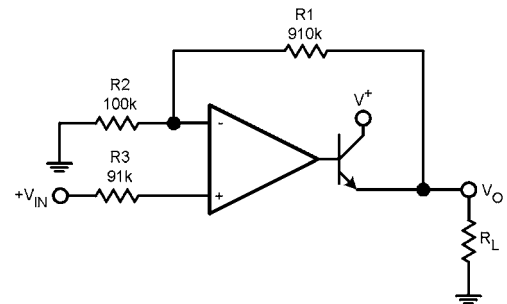
* R not needed due to temperature independent

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

Gain of the Noninverting Amplifier

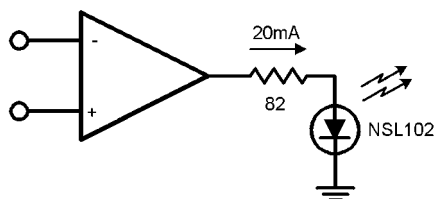


Amplitude Modulator Circuit Schematic

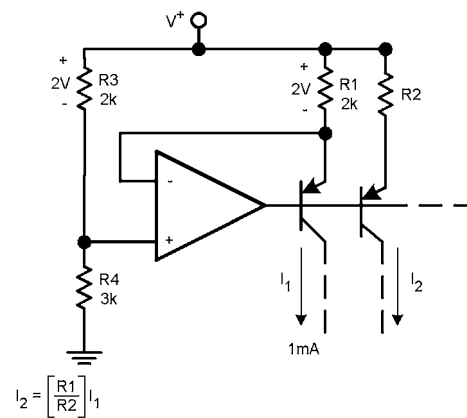


$V_0 = 0$ V_{DC} for $V_{IN} = 0$ V_{DC} , $A_V = 10$

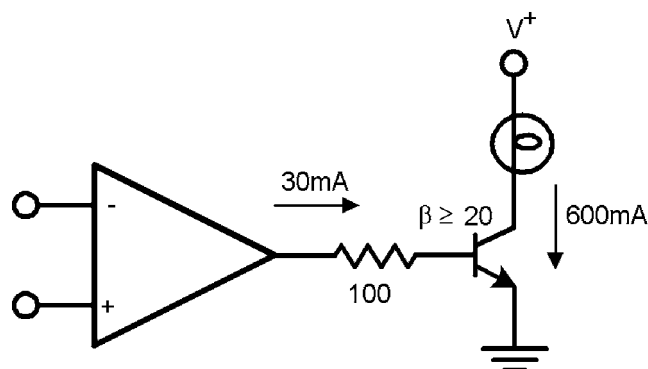
Power Amplifier Schematic



LED Driver Schematic



Fixed Current Sources Schematic



Lamp Driver Schematic



Application Summary

The LM321 op amp can operate with a single or dual power supply voltage, has true-differential inputs, and remain in the linear mode with an input common-mode voltage of $0 V_{DC}$. This amplifier operates over a wide range of power supply voltages, with little change in performance characteristics. At $25^{\circ}C$ amplifier operation is possible down to a minimum supply voltage of $3V$.

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 $-0.3 V_{DC}$ (at $25^{\circ}C$). An input clamp diode with a resistor to the IC input terminal can be used.

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

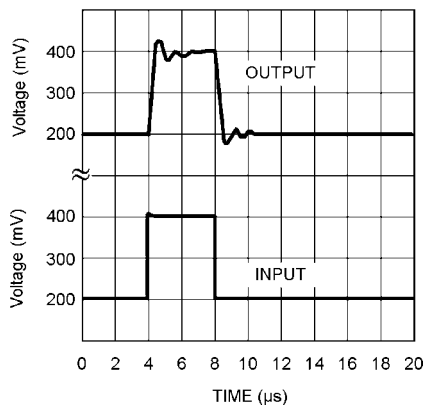
The bias network of the LM321 establishes a supply current which is independent of the magnitude of the power supply voltage over the range of from $3 V_{DC}$ to $30 V_{DC}$.

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. The larger value of output source current which is available at $25^{\circ}C$ provides a larger output current capability at elevated temperatures than a standard IC op amp.

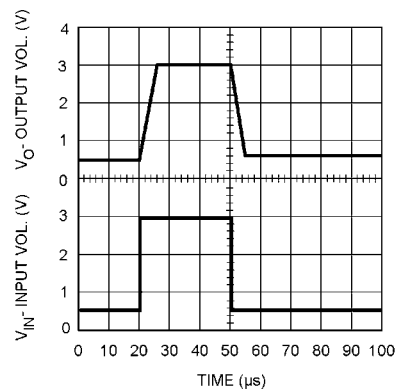
The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used.

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.

Characteristics Curves



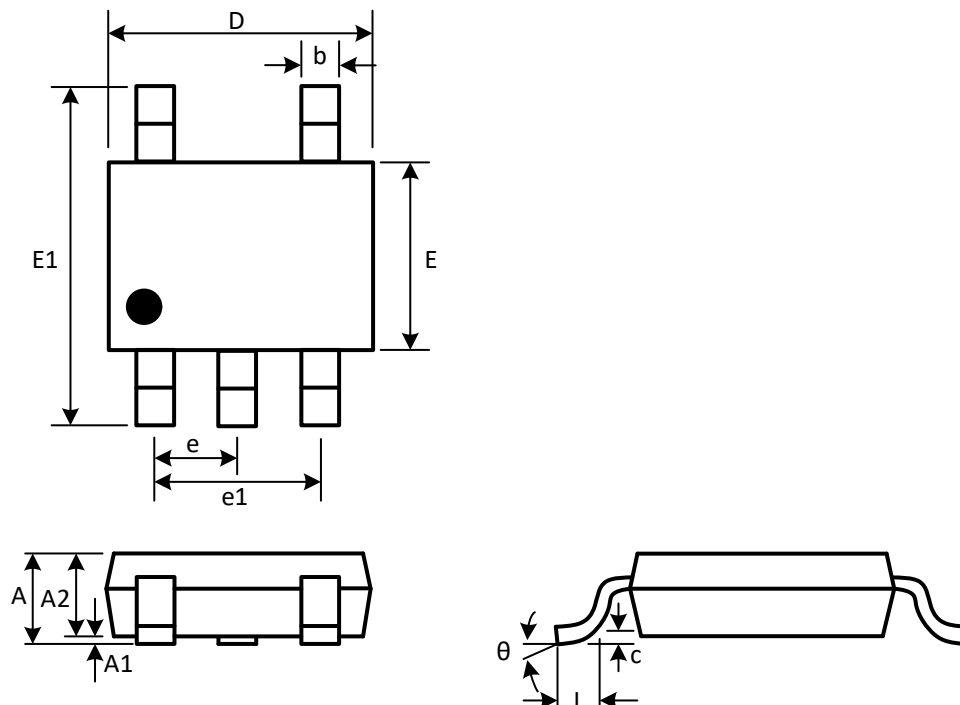
Small Signal Pulse Response



Large Signal Pulse Response



Package Outline Dimensions
SOT-23-5L



(Unit: mm)

Symbol	Min	Max
A	1.050	1.250
A1	0.000	0.100
A2	1.050	1.150
b	0.300	0.500
c	0.100	0.200
D	2.820	3.020
e	0.950(BSC)	
e1	1.800	2.000
E	1.500	1.700
E1	2.650	2.950
L	0.300	0.600
θ	0°	8°



Attention

- Any and all HUA XUAN YANG ELECTRONICS products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your HUA XUAN YANG ELECTRONICS representative nearest you before using any HUA XUAN YANG ELECTRONICS products described or contained herein in such applications.
- HUA XUAN YANG ELECTRONICS assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all HUA XUAN YANG ELECTRONICS products described or contained herein.
- Specifications of any and all HUA XUAN YANG ELECTRONICS products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.
- HUA XUAN YANG ELECTRONICS CO.,LTD. strives to supply high-quality high-reliability products. However, any and all semiconductor products fail with some probability. It is possible that these probabilistic failures could give rise to accidents or events that could endanger human lives, that could give rise to smoke or fire, or that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all HUA XUAN YANG ELECTRONICS products(including technical data, services) described or contained herein are controlled under any of applicable local export control laws and regulations, such products must not be exported without obtaining the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written permission of HUA XUAN YANG ELECTRONICS CO.,LTD.
- Information (including circuit diagrams and circuit parameters) herein is for example only ; it is not guaranteed for volume production. HUA XUAN YANG ELECTRONICS believes information herein is accurate and reliable, but no guarantees are made or implied regarding its use or any infringements of intellectual property rights or other rights of third parties.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the HUA XUAN YANG ELECTRONICS product that you intend to use.