



General Description

The LM321MFX/NOPB brings performance and economy to low power systems. With a high unity gain frequency and a guaranteed 0.4V/us slew rate, the quiescent current is only 430 μ A/amplifier (5V). 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.

The LM321MFX/NOPB is available in the SOT23-5L package. Overall the LM321MFX/NOPB 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.

Application Circuit

DC Summing Amplifier
(VIN's \geq 0 VDC and VO \geq VDC)

Feature :

- (VCC = 5V, TA = 25°C. Typical values unless specified)
- Gain-Bandwidth product 1MHz
- Low supply current 430 μ A
- Low input bias current 45nA
- Wide supply voltage range +3V to +32V
- Stable with high capacitive loads
- Single version of LM324

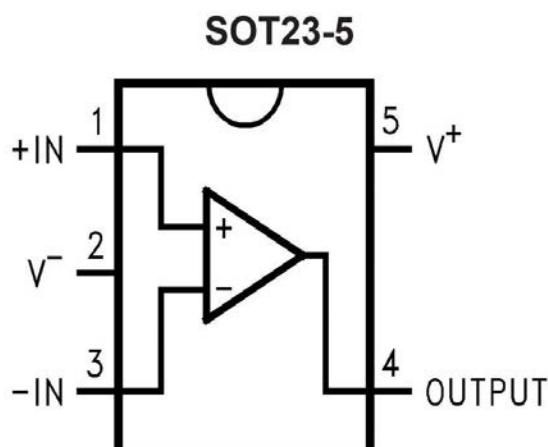
Applications :

- Chargers
- Power supplies
- Industrial: controls, instruments
- Desktops
- Communications infrastructure

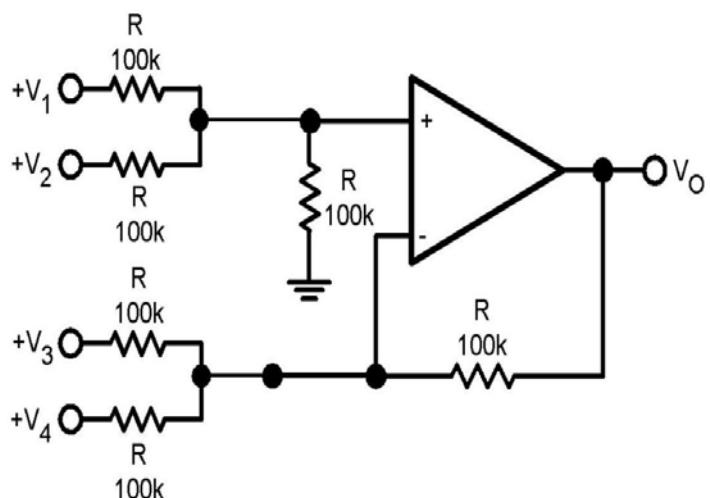
Ordering Information

| Part Number | Package | Package Marking |
|---------------|-----------|-----------------|
| LM321MFX/NOPB | SOT-23-5L | A63 A |

Connection Diagram :



Top View



Where: $V_0 = V_1 + V_2 - V_3 - V_4$, $(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_0 > 0$ VDC



Absolute Maximum Ratings (Note 1)

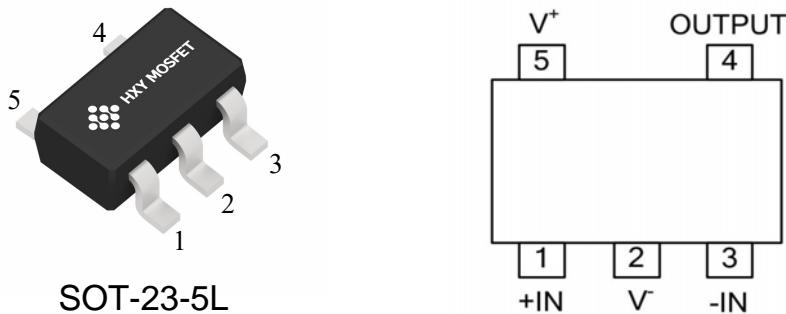
If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

| Parameter | Symbol | Ratings | Unit |
|--|------------------|-----------------|------|
| Supply Voltage (V+ - V-) | VCC | 32 | V |
| Differential Input Voltage | VI (DIFF) | ±Supply Voltage | V |
| Input Current (VIN < -0.3V) (Note 6) | IC | 50 | mA |
| Input Voltage | | -0.3V to +32V | V |
| Output Short Circuit to GND, V ⁺ ≤15V and TA = 25°C | | Continuous | W |
| Thermal Resistance to Ambient | R _{θJA} | 265 | °C/W |
| Junction Temperature (Note 3) | T _J | 150 | °C |
| Storage Temperature Range | T _{STG} | -65~+150 | °C |
| ESD Tolerance (Note 10) | | 300 | V |
| Mounting Temperature Lead Temp (Soldering, 10 sec) | | 260 | °C |
| Infrared (10 sec) | | 215 | °C |

Operating Ratings (Note 1)

| Parameter | Symbol | Ratings | Unit |
|-------------------|----------------|---------|------|
| Temperature Range | T _A | -40~85 | °C |
| Supply Voltage | V ⁺ | 3~30 | V |

PIN CONFIGURATION



| PIN NO. | PIN NAME | DESCRIPTION |
|---------|----------------|---------------------|
| 1 | +IN | Non-inverting input |
| 2 | V- | Ground |
| 3 | -IN | Inverting input |
| 4 | OUTPUT | Output |
| 5 | V ⁺ | Power supply |



Electrical Characteristics (Ta = 25°C unless otherwise specified)

Unless otherwise specified, all limits guaranteed for at TA = 25°C; V+ = 5V, V- = 0V, VO = 1.4V.
Boldface limits apply at temperature extremes.

| Parameter | Symbol | Test Condition | Min (Note 5) | Typ (Note 4) | Max (Note 5) | Unit |
|---|----------|--|-----------------|-----------------|--------------------|------|
| Input Offset Voltage | VOS | (Note 7) | | 2 | 7 9 | mV |
| Input Offset Current | IOS | | | 5 | 50 150 | nA |
| Input Bias Current (Note 8) | IB | | | 45 | 250 500 | nA |
| Input Common-Mode Voltage Range | VCM | V+ = 30V (Note 9) For CMRR > = 50dB | 0 | | V+ - 1.5 V+ - 2 | V |
| Large Signal Voltage Gain | AV | (V+ = 15V, RL = 2kΩ VO = 1.4V to 11.4V) | 25 15 | 100 | | V/mV |
| Power Supply Rejection Ratio | PSRR | RS ≤ 10kΩ, V+ ≤ 5V to 30V | 65 | 100 | | dB |
| Common Mode Rejection Ratio | CMRR | RS ≤ 10kΩ, | 65 | 85 | | dB |
| Output Swing | VOH | V+ = 30V, RL = 2kΩ | 26 | | | V |
| | | V+ = 30V, RL = 10kΩ | 27 | 28 | | V |
| | VOL | V+ = 50V, RL = 10kΩ | | 5 | 20 | mV |
| Supply Current, No Load | IS | V+ = 5V, | | 0.430 0.7 | 1.15 1.2 | mA |
| | | V+ = 30V, | | 0.660 1.5 | 2.85 3 | mA |
| Output Current Sourcing | I SOURCE | VID = +1V, V+ = 15V, VO = 2V | 20 10 | 40 20 | | mA |
| Output Current Sinking | I SINK | VID = -1V V+ = 15V, VO = 2V | 10 5 | 20 8 | | mA |
| | | VID = -1V V+ = 15V, VO = 0.2V | 12 | 100 | | μA |
| Output Short Circuit to Ground (Note 2) | IO | V+ = 15V | | 40 | 85 | mA |
| Slew Rate | SR | V+ = 15V, RL = 2kΩ, VIN = 0.5 to 3V CL = 100pF, Unity Gain | | 0.4 | | V/μs |
| Gain Bandwidth Product | GBM | V+ = 30V, f = 100kHz, VIN = 10mV, RL = 2kΩ, CL = 100pF | | 1 | | MHz |



Electrical Characteristics (Ta = 25°C unless otherwise specified)

Unless otherwise specified, all limits guaranteed for at TA = 25°C; V+ = 5V, V- = 0V, VO = 1.4V.
Boldface limits apply at temperature extremes.

| Parameter | Symbol | Test Condition | Min (Note 5) | Typ (Note 4) | Max (Note 5) | Unit |
|--------------------------------|--------|---|-----------------|-----------------|-----------------|--------|
| Phase Margin | φm | | | 60 | | deg |
| Total Harmonic Distortion | THD | f = 1kHz, AV = 20dB RL = 2kΩ, VO = 2VPP, CL = 100pF, V+ = 30V | | 0.015 | | % |
| Equivalent Input Noise Voltage | en | f = 1kHz, RS = 100Ω V+ = 30V | | 40 | | nV/√Hz |

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 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.

Note 3: The maximum power dissipation is a function of TJ(MAX), qJA, and TA. The maximum allowable power dissipation at any ambient temperature is PD = (TJ(MAX) - TA)/ qJA. All numbers apply for packages soldered directly onto a PC board.

Note 4: Typical values represent the most likely parametric norm.

Note 5: All limits are guaranteed by testing or statistical analysis.

Note 6: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than -0.36V (at 25°C).

Note 7: VO @ 1.4V, RS = 0W with V+ from 5V to 30V; and over the full input common-mode range (0V to V+ - 1.5V) at 25°C.

Note 8: 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.

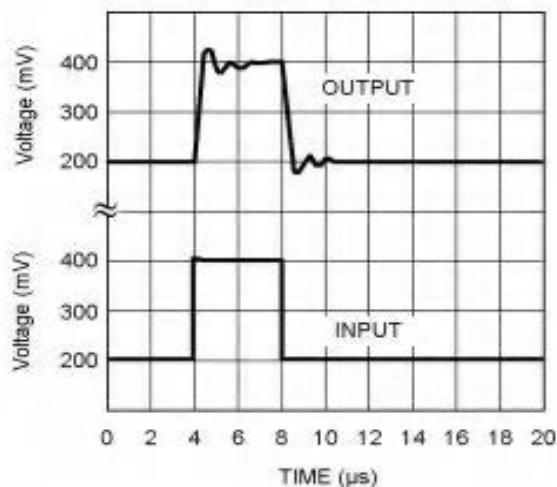
Note 9: The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is V+ - 1.5V at 25°C, but either or both inputs can go to +32V without damage, independent of the magnitude of V+.

Note 10: Human Body Model, 1.5kW in series with 100pF.

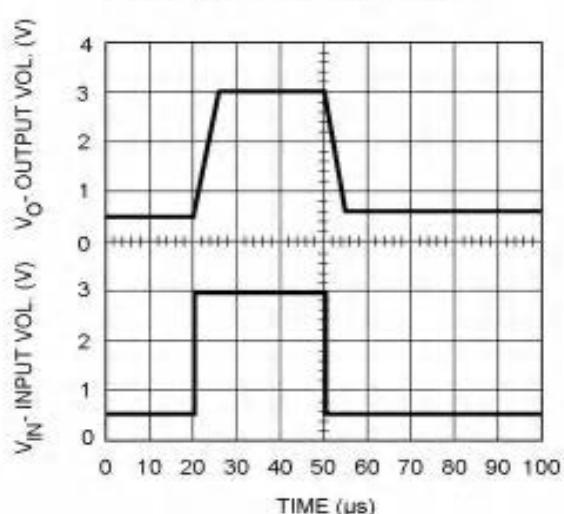


Typical Performance Characteristics (Unless otherwise specified, $V_S = +5V$, single supply, $T_A = 25^\circ C$.)

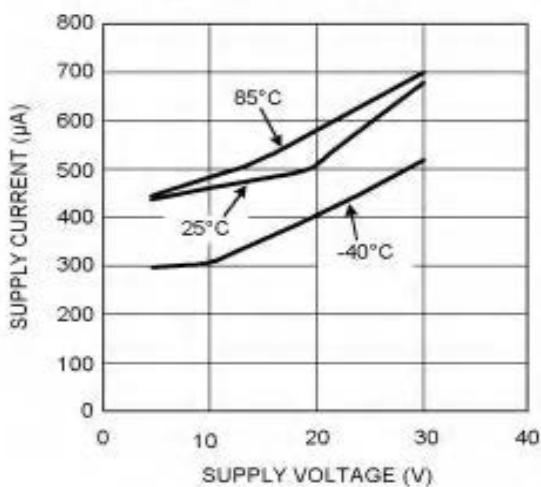
Small Signal Pulse Response



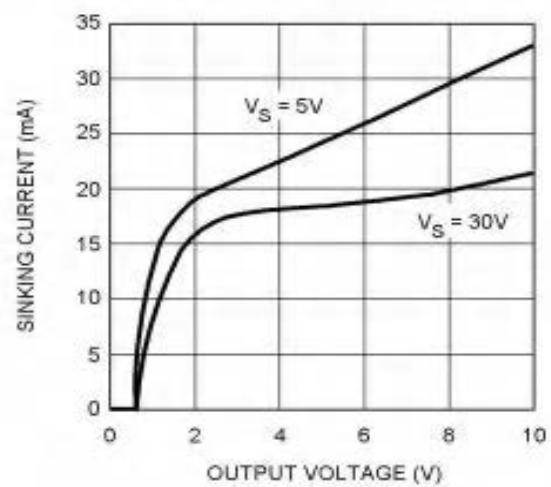
Large Signal Pulse Response



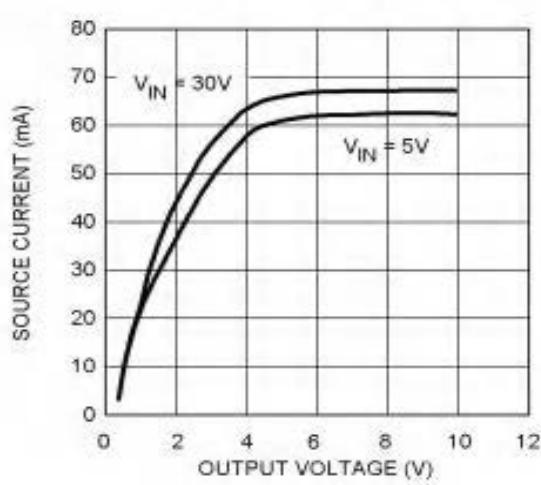
Supply Current vs. Supply Voltage



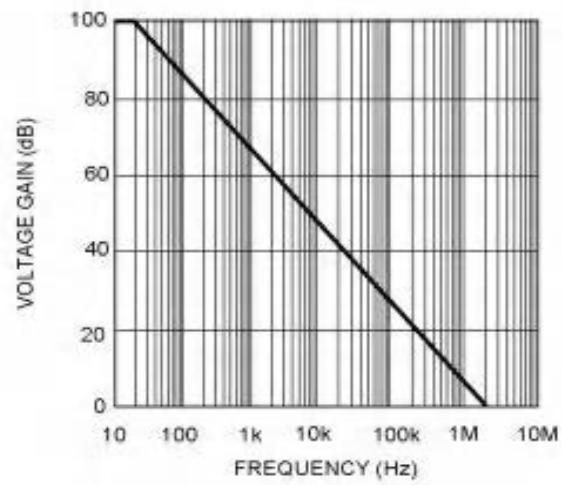
Sinking Current vs. Output Voltage



Source Current vs. Output Voltage

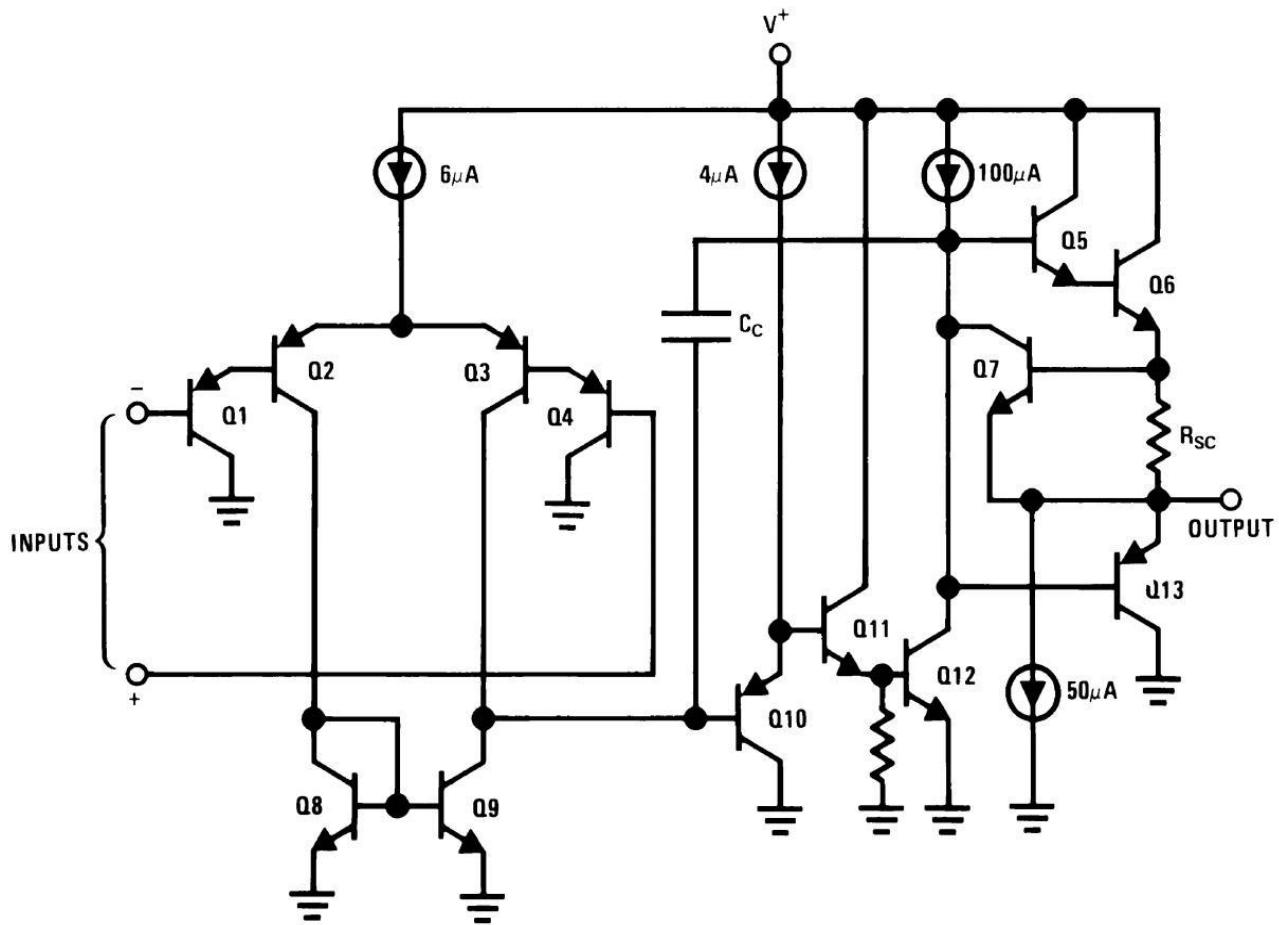


Open Loop Frequency Response

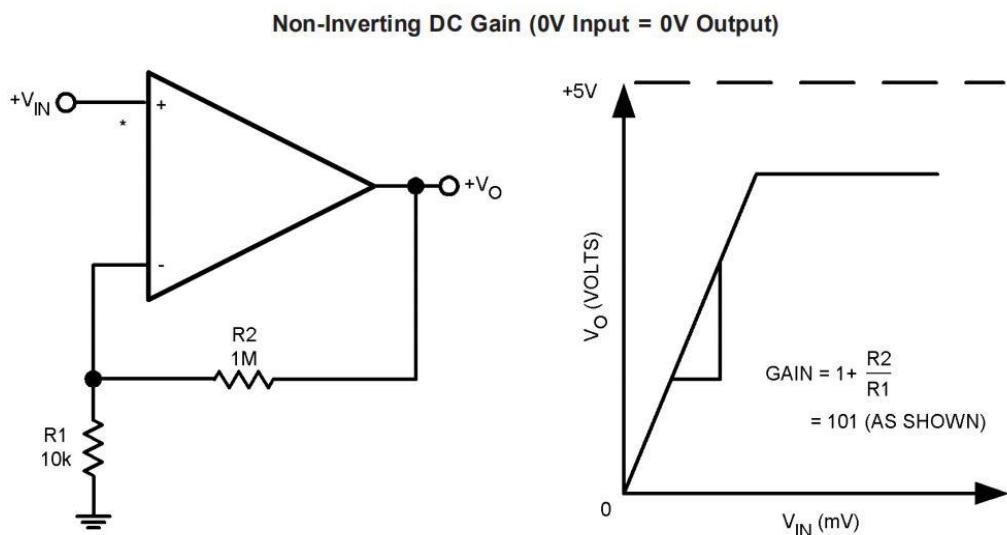




Simplified Schematic :



Typical Applications :

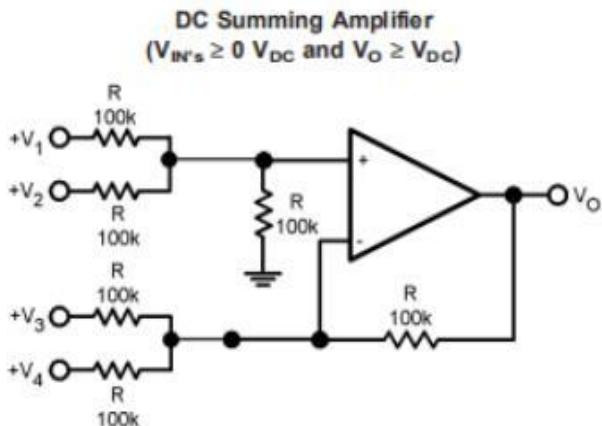
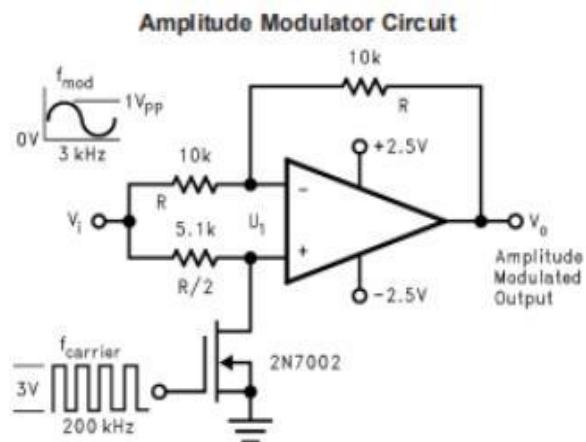


* R NOT NEEDED DUE TO TEMPERATURE INDEPENDENT I_{IN}

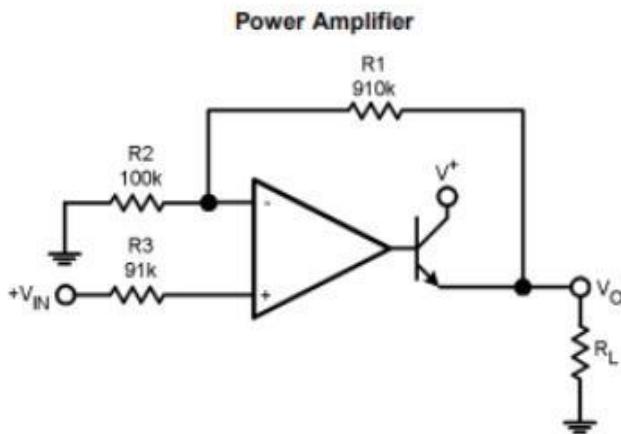


Typical Applications :

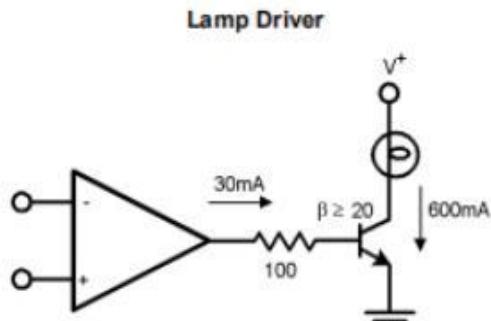
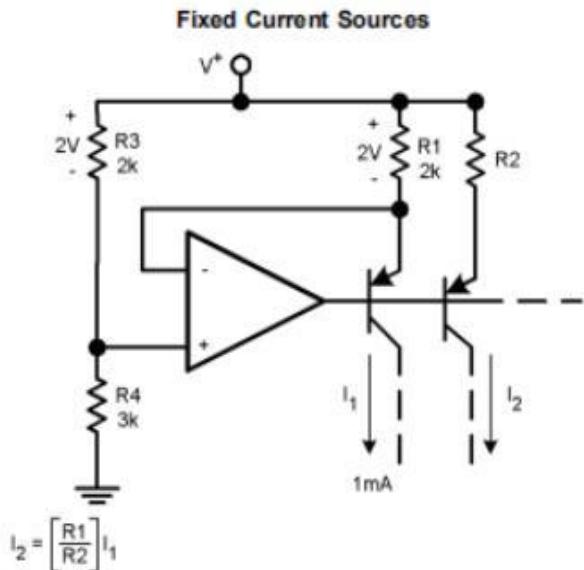
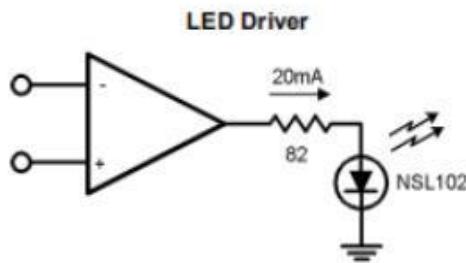
Typical Applications (Continued)



Where: $V_0 = V_1 + V_2 - V_3 - V_4$, $(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_O \geq 0$ V_{DC}

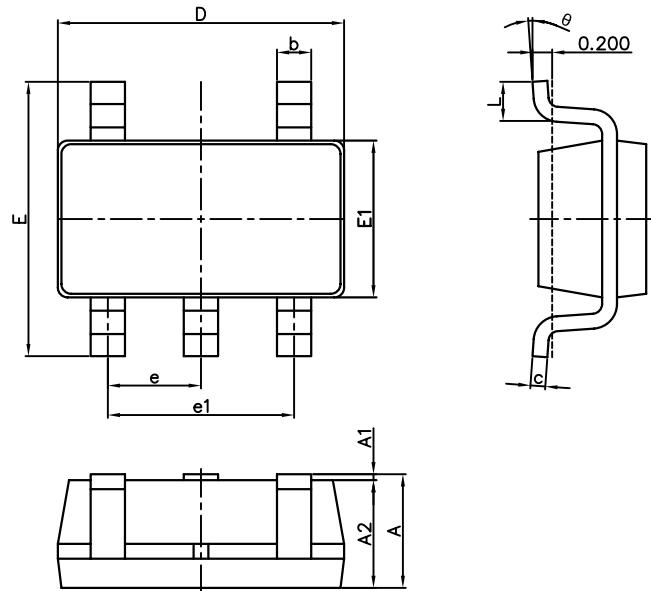


$V_0 = 0$ V_{DC} for $V_{IN} = 0$ V_{DC} , $A_V = 10$





SOT-23-5L Package Outline Dimensions



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min. | Max. | Min. | Max. |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 2.650 | 2.950 | 0.104 | 0.116 |
| E1 | 1.500 | 1.700 | 0.059 | 0.067 |
| e | 0.950(BSC) | | 0.037(BSC) | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |



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